

II Cybernetic Frontiers

**Both Sides of
the Necessary
Paradox
(Conversations
with Gregory
Bateson)**

**Fanatic Life
and
Symbolic
Death
Among the
Computer Bums**



Stewart Brand

The publisher would like you to know that the author of *Two Cybernetic Frontiers* founded and edited the **WHOLE EARTH CATALOG**.

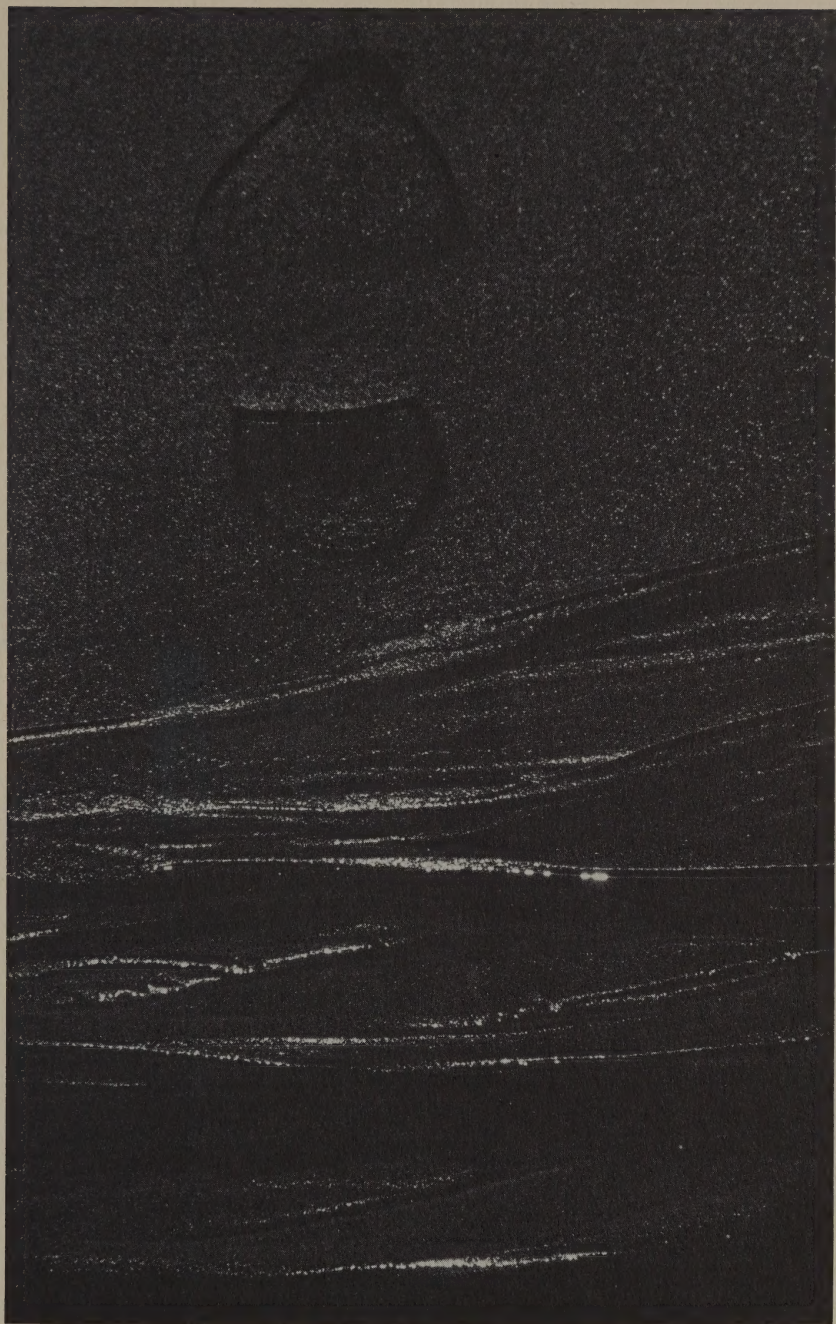
Both Sides of the Necessary Paradox

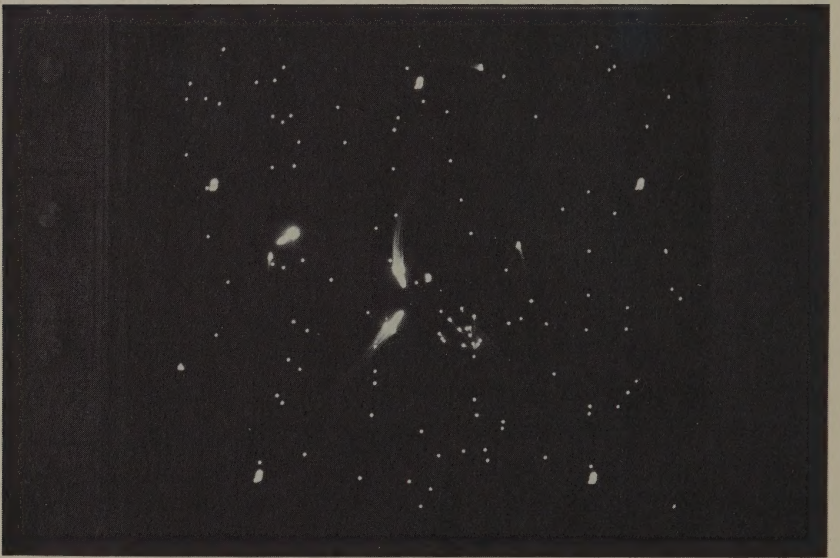
Gregory Bateson is a naturalist, a cybernetic philosopher, anthropologist, psychologist, former husband of Margaret Mead, and formulator of the Double Bind theory of schizophrenia. He's tall (6'5"). This interview is a jagged journey among the wholesome paradoxes that (thank God) undermine human conscious purpose. We visit cybernetically-perceived pathologies of the mind, of the laboratory, of natural history and human history, and we take Taoistic medicine, bitter and sweet. Learning is paradoxical. Health is complexity.

Fanatic Life & Symbolic Death Among the Computer Bums

A photo and tape report on what's lively in computer science. The irrepressible computer-game of Spacewar—a special enthusiasm of the hackers (computer bums, technicians)—is found to have belied predictions and plans for computer use, delivering more fun and less control to the whole field. We visit an Intergalactic Spacewar Olympics at Stanford's Artificial Intelligence Laboratory, as well as the on-line network linking all of America's major computer centers, an idyllic corporate research center, and a People's computer facility. Marvels are told. No predictions are made.

The front cover illustration is a sumi ink painting the author picked up in Kyoto, Japan, for 800 yen, about \$2.





II Cybernetic Frontiers

by Stewart Brand

Galaxy Cluster

This book is dedicated to the difference.

Computer Spacewar

Random House ● Bookworks

Contents

Preface	7
Both Sides of the Necessary Paradox	9
Epilog I — The Evolutionary Idea	35
Fanatic Life and Symbolic Death	
Among the Computer Bums	39
Appendix One: Access to Computers	80
Appendix Two : Your Own Spacewar	83
Epilog II — Primordial Fuzz	86
Softwar	91

Credits

Photographs for "Computer Bums" by Annie Liebovitz
(Rolling Stone).

Photographs for "Paradox" and front and back pages
by Stewart Brand.

All prints by Chong Lee, San Francisco.

Thanks for editorial assistance to Jann Wenner and Lewis Lapham.

Typesetting and layout by Diana Fairbanks,
Fairbanks-Parker, Sausalito, California.

Cover design by Elizabeth Fairbanks.

Preface

THESE TWO PIECES first were printed, somewhat condensed and more scantily illustrated, in periodicals. Jann Wenner at **Rolling Stone** initiated and published "Computer Bums" (December, 1972). "Paradox" was in **Harper's** (November, 1973), supervised by Lewis Lapham. Payment from the **Stone** was \$800, from **Harper's** \$1000 (split fifty-fifty with Bateson).

I estimate that "Computer Bums" is the better article, more easily informative, pursuing a subject that will directly inform more people's lives as the new minicomputers come to make themselves indispensable in home and pocket. Nevertheless I'm billing it behind the awkward piece on Gregory Bateson because what Bateson is getting at, I'm convinced, will *indirectly* inform damn near everybody's lives.

The field of cybernetics is still busy finding out what it is. Our comprehension has grown used to the concepts of matter and energy, but the burden of cybernetics—information—continues to boggle us. Weightless energyless *differences* fly about making patterns which are apparently nothing but which move the somethings with mysterious regularity. Meat learns; machines learn. An absence is as significant as a presence (*You may write an angry reply to a letter you didn't receive—Bateson*). The rules of articulation of a system are inarticulate within that system, which makes things difficult for the cybernetician, who has no way of standing outside his science. It is a science of essences, a slippery business. Information, energy, and matter (and life) make an inseparable whole, but there is yet no theory to link them formally.

Every part of cybernetics research is jumping with fascinating activity. In this book I'm focusing on two frontiers that look particularly poignant and promising. Though polar opposites in their relation to computing machines, they are parallel in their relation to Man's special pride, conscious purposefulness.

Both subvert it.

—SB

*Knowledge will never be able to
replace respect in man's dealings
with ecological systems.*

—Roy Rappaport

Both Sides of the Necessary Paradox

CYBERNETICS IS THE SCIENCE of communication and control. It has little to do with machines unless you want to pursue that special case. It has mostly to do with life, with maintaining circuit.

I came into cybernetics from preoccupation with biology, world-saving, and mysticism. What I found missing was any clear conceptual bonding of cybernetic whole-systems thinking with religious whole-systems thinking. Three years of scanning innumerable books for the **Whole Earth Catalog** didn't turn it up. Neither did considerable perusing of the two literatures and taking thought. All I did was increase my conviction that systemic intellectual clarity and moral clarity must reconvene, mingle some notion of what the hell consciousness is and is for, and evoke a shareable self-enhancing ethic of what is sacred, what is right for life.

Tall order. In the summer of '72 a book began to fill it for me: **Steps to an Ecology of Mind**, Gregory Bateson, Ballantine Books, 1972, 517 pp., \$1.95.

After reading it I couldn't understand why Gregory Bateson was famous only for conceiving the Double Bind theory of schizophrenia in the '50s and conceiving a daughter Catherine with co-anthropologist Margaret Mead in the '30s. Here in one single-minded book was highly original application of cybernetics, biology, linguistics, psychology, and formal logic to field work with

New Guinea and Balinese natives, porpoises, alcoholics, schizophrenics, beetles, and national histories. Here were statements such as:

- *No organism can afford to be conscious of matters with which it could deal at unconscious levels.*
- *Mere purposive rationality unaided by such phenomena as art, religion, dream, and the like, is necessarily pathogenic and destructive of life; its virulence springs specifically from the circumstance that life depends upon interlocking circuits of contingency, while consciousness can only see such short arcs as human purpose may direct.*
- *The social scene is nowadays characterized by the existence of a large number of self-maximizing entities which, in law, have something like the status of 'persons' — trusts, companies, political parties, unions, commercial and financial agencies, nations, and the like. In biological fact, these entities are precisely not persons and are not even aggregates of whole persons. They are aggregates of parts of persons.*
- *If Lake Erie is driven insane, its insanity is incorporated in the larger system of your thought and experience.*
- *They say that power corrupts; but this, I suspect, is nonsense. What is true is that the idea of power corrupts.*

So goes one thread in the book, a rigorous scientific refutation of the notion that rational science is adequate to save us. Not bad for a fifth-generation atheist. (*My father, the geneticist William Bateson, used to read us passages of the Bible at breakfast—lest we grow up to be empty-headed atheists.*)

Apparently Bateson's unusual work with the pathologies of individual insanity and alcohol addiction was yielding powerful insights into our social pathologies. Steps to the Mind of Ecology. I wanted more. There were radically different habits of thought going on in Bateson that I wanted to replace some of my habits. I knew that young questers were trekking to his door with the same private fervor one used to associate with pre-popularity Marshall McLuhan or Buckminster Fuller, and that half a dozen disciplines beleaguered

Contents of
Steps to an
Ecology of Mind

Introduction: The Science of Mind and Order	xvii
Part I: Metalogues	
Metalogue: Why Do Things Get in a Muddle	3
Metalogue: Why Do Frenchmen?	9
Metalogue: About Games and Being Serious	14
Metalogue: How Much Do You Know?	21
Metalogue: Why Do Things Have Outlines?	27
Metalogue: Why a Swan?	33
Metalogue: What Is an Instinct?	38
Part II: Form and Pattern in Anthropology	
Culture Contact and Schismogenesis	61
Experiments in Thinking about Observed Ethnological Material	73
Morale and National Character	88
Bali: The Value System of a Steady State	107
Style, Grace, and Information in Primitive Art	128
Comment on Part II	153
Part III: Form and Pathology in Relationship	
Social Planning and the Concept of Deutero-Learning	159
A Theory of Play and Fantasy	177
Epidemiology of a Schizophrenia	194
Toward a Theory of Schizophrenia	201
The Group Dynamics of Schizophrenia	228
Minimal Requirements for a Theory of Schizophrenia	244
Double Bind, 1969	271
The Logical Categories of Learning and Communication	279
The Cybernetics of "Self": A Theory of Alcoholism	309
Comment on Part III	338
Part IV: Biology and Evolution	
On Empty-Headedness among Biologists and State Boards of Education	343
The Role of Somatic Change in Evolution	346
Problems in Cetacean and Other Mammalian Communication	364
A Re-examination of "Bateson's Rule"	379
Comments on Part IV	400
Part V: Epistemology and Ecology	
Cybernetic Explanation	405
Redundancy and Coding	416
Conscious Purpose versus Nature	432
Effects of Conscious Purpose on Human Adaptation	446
Form, Substance and Difference	454
Comment on Part V	472
Part VI: Crisis in the Ecology of Mind	
From Versailles to Cybernetics	477
Pathologies of Epistemology	486
The Roots of Ecological Crisis	496
Ecology and Flexibility in Urban Civilization	502
The Published Work of Gregory Bateson	514
Index	527

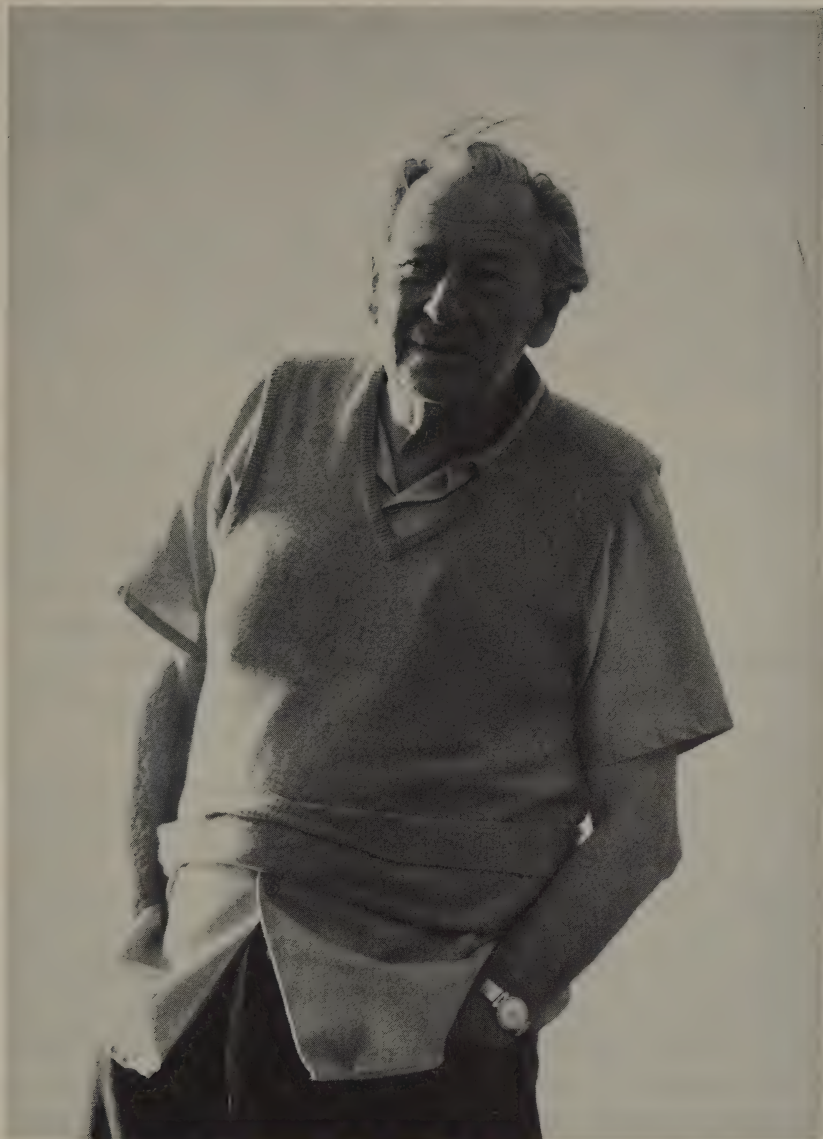
him with the errands attendant on heavyweight status. I had to find some way to hang out with him without trespassing excessively. Researching this article was the solution.

“The Biology of Culture and Consciousness” is the modest title of Bateson’s course at the University of California’s new Santa Cruz campus. I took my tape recorder to two meetings of the class, then to his half-finished house in Big Sur for several hours talk about matters not in the book or the class. It was so damned nice, the upper-Bohemian splendor on the mountain there with his family—five-year-old goldy-haired daughter Nora, 21-year-old son John, and current broad Lois (she is weary of always being reported as “third wife Lois” and suggested this variation). I kept coming back and wound up with too much material, too divergent, and too Socratic (he makes *you* say it) for easy reporting. His discourse is the opposite of a tidy closed system; it persistently veers down primrose paths, off into galaxies of human ignorance, back on itself mirrored, and out of the reach of language. Provoking, demanding, useful as hell and about as convenient.

Double Bind

START ANYWHERE. PARALINGUISTICS. Gregory was investigating that when I first met him briefly in 1960 at the VA Hospital in Palo Alto, California. Paralinguistics is all the communication that goes on besides talk—all the pauses, grunts, sighs, facial and body movements that, it turns out, always convey exactly what you’re *really* at and are always received and (at least unconsciously) understood. “What about lying?” I asked. “Lying is impossible. Your slip is always showing. Some of my fellow psychotherapists are not very happy about that. You pretend so-and-so, and the patient pretends to believe you.”

Paralinguistic communication, functioning as a “context marker,” can enhance or contradict spoken communication. Tone of voice, eyebrows, body stance, etc. make meta-statements such as



Six-foot five, 69, disheveled, Bateson's presence is like that beetling Rodin sculpture of Balzac, only instead of fierce, completely benign. He looks at you critically, optimistically, as if you're going to say something good any minute now.

“I’m joking”, “This is important”, or “Listen carefully, I’m implying”. If I routinely present you with statements and meta-statements which contradict each other—saying I love you and conveying I dismiss you, for example—and you care, and I *punish you either way you take it*, you can count on going nuts, because I’ll force you to believe that my contradiction is in *your* mind. I’ll punish you for obeying me, for disobeying me, and for any move you make toward the exit. Such a “Double Bind” can be so exquisite and exquisitely engrossing that you disappear into another communication mode of your own devising, self-consistent and apart: Schizophrenia.

Gregory (his British accent and irony intact after 16 years of U.S. citizenship): “The Double Bind theory was always stated with a contradiction in it—that it’s not fair when the super-person or the parent or the god or something penalizes the other fellow for having followed the leads and meta-cues previously given. In **Mary Poppins** Mother says, ‘Did my daughters give the other children any gingerbread yet?’ And one daughter hesitates and the other says, ‘Not yet, Mother.’ And the Mother says, ‘Who gave you permission to give away my gingerbread!?’ ”

The classic Bind. “Tell me you love me.” “I love you.” “Why do you only say that when I ask you?” The bouquet is elicited and then destroyed.

Gregory: “Then there is the much more subtle case in which the rug is not switched. Shall we say a loving action is insisted upon by the recipient. The case in which *A* makes a spontaneous affectionate move towards *B*, and *B* grabs it. Which remarkably quickly destroys the relationship. Because the message is delivered into the frame in which it had to be delivered, it becomes a meaningless message. It doesn’t mean any more than the smile of the porpoise, which smiles because he can’t change his face.”

I can hear it. “Tell me you love me.” “I love you.” “Thankyou.” The bouquet, by being elicited, dismisses itself.

Statement and meta-statement; message and context; we’re in the cybernetic domain of hierarchial levels. The Double Bind con-

cept owes much to Bertrand Russell's Theory of Logical Types, which forbids self-reflexive paradoxical statements like *This sentence is false* (is the sentence true?). No class can be a member of itself, is Russell's rule; for a discourse to re-enter itself from above is monstrous. Gregory adds an elaboration I've hears nowhere else: "Between the levels in the meta-ladder there is some sort of black magic which reverses signs. This I've never understood, but it seems certainly to be true in some funny way. What is good for General Motors is not necessarily good for the country—the country being meta to General Motors I take it. *He who kisses the joy as it flies, lives in eternity's sunrise*. Right. You want to kiss it as it flies and not make a meta-comment about kissing it."

In other words, "This sentence is true" voids itself of meaning as thoroughly as "This sentence is false". They both merge two levels inappropriately. Consider again the effect of "Tell me you love me", or "Wanna hear the funniest joke ever?". Curdle.

Gregory: "A joke is a Double Bind, but some of them aren't funny. I don't know the difference please between jokes and schizophrenia and religion. That they all belong in the same box I'm convinced. Like the Bread-and-Butterfly."

"Hm?" says I.

"A great addition to the Theory of Evolution—which theory Lewis Carroll I guess didn't like. The Bread-and-Butterfly has wings of bread and butter and a head made of a lump of sugar. Alice says, 'What does it live on?' The answer is, 'Weak tea with cream in it.' At this point she begins to perceive a difficulty: its head will dissolve in its food. So she says, 'What happens if it can't get any?'"



*Tenniel's
Bread-and-Butterfly in
Through the Looking Glass.*

And the Gnat, who's acting as guide, says, 'It dies.' Alice says, 'That must happen rather often.' The Gnat says, 'It always happens.'

"I think this was intended, you know, as a caricature of Darwinism, and it's not a bad caricature of Natural Selection, except that it adds an entirely new principle to the whole evolutionary process, which is in a word the principle of the Double Bind. The Bread-and-Butterfly does not die because its head dissolves in tea; it does not die because it can't get food; it dies because *either* its head dissolves in tea *or* it can't get food. You can't localize the cause of death."

"If paradox is the structure of the Double Bind," I ask, "what drives it? Control?"

Gregory sighs. "At the first level, control, yes. To *want* control is the pathology, not that the person gets control because of course you never do."

"How innocent is the victim?" I inquire innocently.

"Not innocent at all. I had a schizophrenic patient who said, 'If it's not the way I want it, I'll prove it!' That's the back Double Bind. He's fighting a battle, and he's fighting with this same tool. He can't let go of the tool."

"What's the way out?" I ask, as mildly as possible, considering that it's the question I came to ask.

"There's various ways of making these discoveries—the discoveries that set you free. One of them is to sit in the lotus position for several hours a day. Another is to go around in the world twisting people's tails to see what happens—the symptoms of schizophrenia *are* weapons. Schizophrenia is, often, a self-initiatory voyage. All these trips to hell . . ."

The Tao

GREGORY TALKS SLOWLY, with ruminative pauses. This is a long one. Let dots (. . .) signify his paralinguistic pauses.

“. . . The moment you want to ask the question, ‘What do you do about it?’, that question itself chops the total ecology. . . . I’m really talking Taoism you know. The pathology is the breach of Taoism. And you say ‘Well now what’s the cure for a breach of Taoism?’ You want to say another breach of Taoism is the cure for it.”

I ask for a definition of ‘pathology’.

Long pause. “. . . It is so that a nice piece of forest or a tidepool or whatever—if it’s doing ‘well’—is slowly increasing its complexity up to a certain point. There’s an upper limit to how much the oxygen or space or whatever will support.”

My Biology speaks up, “Is that termed ‘climax?’”

“That’s called climax ecology, yes. Now, climax is very unstable you know. As long as it isn’t disturbed it goes on forever, but one discordant idea introduced and the whole thing falls to pieces. Wasn’t it Christ who said, ‘Offences must come?’ The classical instance I use is the introduction of the idea of conquest into Hawaii. These rough blackbirders, pirates, whalers, who had a gun or two, a couple of cannon, told Kamehameha the First that border wars were silly. Everybody had border wars for hundreds of years, you know, and a few people got killed, and the young men had a lot of fun, and everybody was proud. The whalers said, ‘That’s not what you do. You’ve got to conquer them.’ And from then on the thing was fucked.”

On another Pacific isle, Bali, the natives told Gregory that their phrase for the period before contact with Whites is ‘when-the-world-was-steady’.

“The idea of sanity or health or whatever has got to be somehow related to the whole concept of climax. The definition of pathology then is: those things which destroy climax. They destroy it to the point, where 50 species lived you can now have only five. These pathologies leave a dull world.

“The South Downs of England. These are rounded chalk hills. When I was a boy I used to collect the flowers and beetles. The Downs were covered with a turf about an inch high, and that turf had 30 or 40 species of plants in it, and corresponding insects, et cetera. Little orchids, and such lovely things. A rich hunting ground for me—I was 12. It was kept in order by sheep and by rabbits, who grazed it. The sheep were kept in order by farmers, who—after all—*The Lord is my shepherd*, but the butcher employs him.

“The automobile then was introduced into the system. It was too expensive to fence the Downs, and the sheep kept getting on the roads. This annoyed the automobiles, and in the end the sheep had to be done away with. This left the rabbits, who did a fairly good job for some years. The rabbits were kept down by the farmers with shotguns who went for walks in the evening. They enjoyed this very much, but they shot the rabbits because they were, quote, vermin. So, when the Australians (where Rabbit really is vermin, or was vermin) discovered how to exterminate rabbits with a virus disease, they decided it was a good idea to exterminate rabbits. There was a period of three weeks when the roads of England stunk with dead rabbits.

“Now there are no rabbits, and when I went and visited the South Downs four years ago, the turf instead of being an inch high was three feet high, consisted of about five species, namely those species that could stand living in both short and tall-grass situations. There were a few invading plants too—plants that could stand anything and go anywhere. What you get, you see, is the more you make these sudden changes—and the emphasis is on the word ‘sudden’—the more you fractionate down to only accept the most flexible. These in the end are the plants we call weeds. The same is true of human society.”

Weeds—plant, animal, and human—are the most flexible and least interdependent, least complexly involved. Consequently there is less biomass, less life, in the system. I've got so far from Bateson that health is complexity, and disease is bringing complexity down to monocrop, to monotony. Now I want a definition of medicine. "How does Taoism relate to the readers of **Harper's**?"

Gregory: "I should think remarkably little. . . . We keep coming back to this, you know. They say China came back to it every four or five hundred years. When the government really got into trouble they would call for the Taoists to come and get them out: 'What do we do?' And the Taoists would say,

'You follow the Way,'

and that's all they would ever say.

"Let's put it another way. Suppose that the Tao can only be discovered by the juxtaposition of two or more representations, descriptions, explanations, whatever you want to call it, and that one then said, 'What two or more explanations could one present to the readers of **Harper's** such that they might get a ghost of a feeling that there was something about a Tao?' "

Nora, sitting on Gregory's lap, seizes the pause. "Daddy? Daddy. How do they make plastic?"

"They put it in a thing. They squeeze the thing and it comes out again in strings or shapes."

Nora: "In the shape of plastic?"

"In the shape of whatever it is. A pot. A pair of pants. Those very big trucks that you see going down the road, that don't have anything written on them, your big sister Cathy says they really just carry the basic mixture. They go all over the country, and when someone wants beefsteak, they take a little of it, and they put some red dye in it, and they shape it up, and they roast it, and it's beefsteak. And if they want candles, they make it come out in cylinders, and they make it white, and it's candles. It's all really the basic mixture. It doesn't taste of anything. It doesn't smell of anything. Odorless, tasteless, and non-toxic. Mhm. So, if you tease me I'll tease you."

He chortles with her and returns to musing. "Two illustrations such that our reader shall be thereby squeezed up a level of abstraction. . . . I think this is why Warren McCulloch was always fascinated with intransitive preference."

"With which?" I'm on Nora's level now, though I've heard much of the late McCulloch, a pioneer cybernetician at MIT and one of Gregory's personal saints.

"That A is preferred to B , B is preferred to C , and A is not preferred to C . C is preferred to A . This does some very funny things to the problem of translation obviously. It incidentally indicates that the whole of economics is probably founded on fallacy. It is necessary for economics that preference curves shall not intersect. Now, it is possible to train mammals to accept the monetary scale, but it might be a gross distortion of the cosmos."

Intransitive preference is the kids' game of Paper-Scissors-Stone. Paper covers Stone, Stone breaks Scissors, Scissors cuts Paper. Whatever hand configuration you choose may be either weapon or target or both or neither, depending entirely on what the other players do. Depending entirely on what the other players do.

I propose: "I've got one for the readers of **Harper's**. What color is a chameleon on a mirror?" Gregory supposes it would find a middle color. I suggest it will cycle endlessly. Neither of us can guess what effect mood will have on the poor beast trying to disappear in a universe of itself. The experiment remains to be run.

Nora: "Daddy, it's almost tea-time." Indeed, reflected late-afternoon sunlight is dazzling up off the Pacific a thousand feet below.

Still in quest of Tao ticklers, Gregory is rummaging through his library looking for Blake's illustration of Job affrighted with visions. "Job's sin is that he's pious. This is the sin which annoys Satan almost more than any other—Satan being also part of God, an angel after all. Uh huh," Gregory looks to see if I got it. Not yet. "So Satan takes on the challenge to smash Job's piety, and you get the whole series of events. Finally God answers Job out of the whirl-

wind: *Who is this that darkeneth counsel by words without knowledge . . . Where wast thou when I laid the foundations of the earth? Canst thou bind the sweet influences of Pleiades, or loose the bands of Orion? . . . Knowest thou the time when the wild goats of the rock bring forth?*—those three chapters of natural history. This is the resolution of the dialectic between having your property destroyed and being pious. The correction for piety is natural history.”



“With Dreams upon my bed thou scarest me & affrightest me with Visions.” William Blake engraving (Bateson collection).

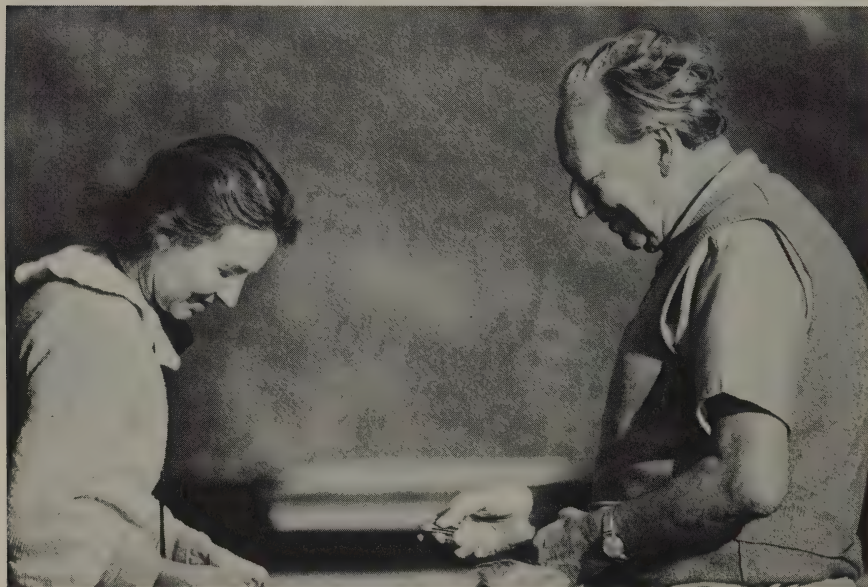
We consider Blake’s engraving, in which, Gregory points out, the Lord resembles Job, and, as you look closer, God’s feet are cloven into hooves. I ask, “Is the horror of the dream that God and Satan are superimposed?”

Gregory: "They're so intimately joined that you will never disentangle them . . . How many sorts of good and evil are there? The first evil evidently was the separation of good and evil."

"Without a difference, nothing happens," I protest.

"And all differences are things of the mind. White paper and black paper. The difference between them is not in the white paper and it's not in the black paper. It's not in the space between them."

Lois Bateson comes over from the kitchen side of the house—it's one enormous room—with a trayful of tea things. As we settle down to sip I inquire just what *is* tea-time. Upper class British born and reared Gregory stays mum as American Lois explains, "It's the afternoon lag. You don't know whether you're hungry or sleepy. Maybe you should take a walk. Something needs to happen. It's usually around five."



Lois and Gregory Bateson at Big Sur.

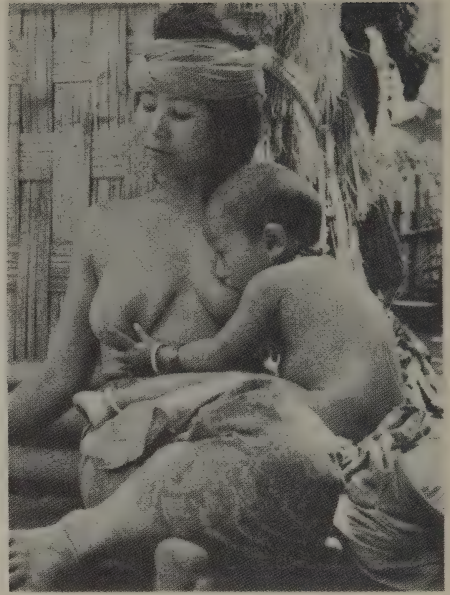
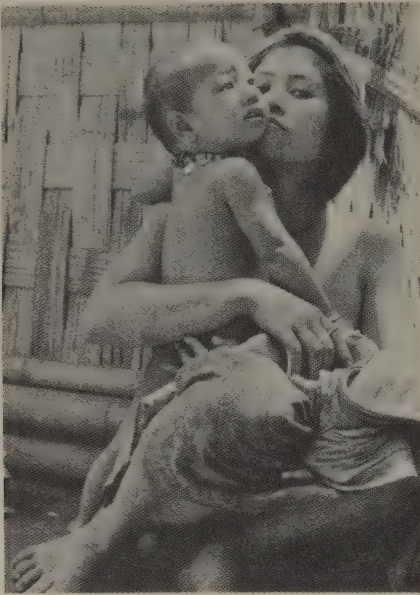
Two Cybernetic Frontiers reader, have some tea. I want to break continuity here, summarize something that didn't happen, and resume from a different angle. I had been fascinated by one paper in *Steps to an Ecology of Mind* called "The Cybernetics of 'Self': A Theory of Alcoholism". In it Bateson analyzes the epistemologically false (and common) view of self which encourages the alcoholic pridefully to insist, "I can beat the bottle," and thereby turn himself into a battle of fictitious enemies. By demonstrating that there's no disconnectable "I", Alcoholics Anonymous can cure the sufficiently desperate alcoholic, can reconnect him with the whole of his personality and universe. Gregory suggests in the book that the structure of personal addiction cycles would be formally the same as cycles of social-economic addiction, such as to DDT, unlimited growth, missionary fervor, and the like. I wanted to ask him what, then, would be a culture-wide equivalent of AA for our civilization-on-a-binge, but we never got to it.

The Lab

THE MAJORITY OF OUR CONVERSATION developed around the theme of the Madness of the Laboratory. As a scholar, Gregory is some kind of throwback to 19th Century science, or to protest against it. Most of his saints—Lamarck, Blake, Boole, Carroll, Samuel Butler—were its critics.

"I am very interested in the miraculously right and miraculously wrong things in 19th Century thinking." I ask him what happened to science by the turn of the century. "It moved into the lab. I went into anthropology, I think, to avoid labs.

He avoided labs alright. He was sent in 1927 to the howling wilderness of New Guinea at the age of 22 to study the natives ("I was supposed to measure their damned skulls"), spent two years up the wrong river, then three years up the right river with the Iatmul tribe. "Then to the Sepik River came Margaret Mead with Reo



"... the give-and-take of stimulus and response between mother and child lacks the sort of climax structure which is characteristic of love and hate in our own culture. The Balinese mother stimulates her child, but when he responds, she is unresponsive and never allows the flirtation to end in any sort of affectionate climax."

(Bajoeng Gede. Aug. 19, 1937.)

*Two photos from a nine-photo sequence
in **Balinese Character.***

Fortune, her then husband, and if you want the story of that, she's just published it all in a book called **Blackberry Winter.**"

Through Margaret, Gregory became acquainted with Ruth Benedict's **Patterns of Culture**, which convinced him that anthropology was about something. He collaborated with Margaret on a still-unsurpassed photographic study of culture called **Balinese Character**, prepared his definitive work on the Iatmul (**Naven**), met the early cyberneticians in America and rewrote the end of **Naven** with a cybernetic explanation of why the Iatmul culture

didn't blow up (the apparent contradictions were in beautiful cybernetic balance).

He took part in the extraordinary Macy Foundation meetings that founded cybernetics in the late '40s and early '50s, briefly taught anthropology at Harvard, was fired for teaching theory to the data-students and data to the theory students and not condemning psychoanalysis, and through Alfred Kroeber was hired in California at the Langley-Porter Clinic to do work on psychiatry and communications (which led to the Double Bind theory). With his field experience he must have been a wooly character to have around a hospital, still no friend to labs.

"Oh the damage that's been done to psychiatric thinking by the clinical bias. The clinical bias being, that there are good things and there are bad things. The bad things necessarily have causes. This is not so true of good things.

"No experimenter links up, say, the phenomena of schizophrenia with the phenomena of humor. Schizophrenia is clinical, and humor isn't even psychology, you know. The two of them *are* closely related, and closely related, both of them, to arts and poetry and religion. So you've got a whole spectrum of phenomena the investigation of any of which throws light on any other. The investigation of none of which is very susceptible to the experimental method."

"Because of non-isolatability?" I think I'm ahead of him this time.

"Because the experiment always puts a label on the context in which you are. You can't really experiment with people, not in the lab you can't. It's doubtful you can do it with dogs. You cannot induce a Pavlovian nervous breakdown—what do they call it, 'experimental neurosis'—in an animal out in the field."

"I didn't know that!" I'm gleeful.

More of the Bateson chortle. "You've got to have a lab."

"Why?"

"Because the smell of the lab, the feel of the harness in which the animal stands, and all that, are context markers which say what sort

of thing is going on in this situation; that you're supposed to be right or wrong, for example.

"What you do to induce these neuroses is, you train the animal to believe that the smell of the lab and similar things is a message which tells him he's got to discriminate between an ellipse and a circle, say. Right. He learns to discriminate. Then you make the discrimination a little more difficult, and he learns again, and you have underlined the message. Then you make the discrimination impossible.

"At this point discrimination is not the appropriate form of behavior. Guesswork is. But the animal cannot stop feeling that he ought to discriminate, and then you get the symptomatology coming on. The one whose discrimination broke down was the experimenter, who failed to discriminate between a context for discrimination and a context for gambling."

"So," says I, "it's the *experimenter's* neurosis that . . ."

". . . Has now become the experimental neurosis of the animal. This whole context business has a Heisenberg hook in it much worse than the atoms ever thought of." (Atomic physicist Heisenberg's famous Uncertainty Principle states that the observer constantly alters what he observes by the meddling act of observation.)

"In the field what happens?"

"None of this happens. For one thing, the stimuli don't count. Those electric shocks they use are about as powerful as what the animal would get if he pricked his leg on a bramble, pushing through.

"Suppose you've got an animal whose job in life is to turn over stones and eat the beetles under them. All right, one stone in ten is going to have a beetle under it. He cannot go into a nervous breakdown because the other nine stones don't have beetles under them. But the lab can make him do that you see."

"Do you think we're all in a lab of our own making, in which we drive each other crazy?"

“You said it, not I, brother,” chuckling. “Of course.”

“OK. What constitutes the Field then in terms of human life? Is there anywhere that *we* are immune to neurosis? Where’s the Field for you?”

Taking it slow now, Gregory: “Well, I keep some flexibility by refusing to specialize. And I like to have more than one boss. To have to please a single one is too narrow.”

“Is the choice of eight harnesses different from having a harness at all?”

“I think so, yes. With my anti-experimental bias I don’t save myself from trouble, but it does have a lot of sideways-opening effects.”

“Say more about sideways.”

“Well, classically grass on the side of the road is more interesting than where the road’s going. I find I make mistakes if I start worrying too much where the road’s going. Such a metaphor as *wrestling*—either with an idea or with a source of data—means a great deal to me. In general I do not know what a paper is going to be about when I start to write it. It emerges out of a sort of wrestling process.

“Now, you can only have a wrestling process if you rigidly believe or care about the meta-hypotheses. You have a rigid belief that there is a no action at a distance, we will say, and you have a case of apparent telepathy to account for. Now you’ve got the data on one side and a stubborn epistemological assertion on the other, and you wrestle with those two somehow. My complaint with the kids I teach nowadays—graduate students and such—is that they don’t really believe anything enough to get the tension between the data and the hypothesis. I mean, they don’t make theory because whatever they may find out doesn’t really impact on theory, because they don’t have any theory they’re willing to hold tight enough to get an impact. It *slides* all the time.”

I resist murmuring the litany of my uncritical generation, “Yeah, well, sure man, *whatever* . . .” I do inquire about his psychedelic

pedigree and am informed, "I got Allen Ginsberg his first LSD. I've had a couple of experiences. One was at Joe Adams' in Big Sur. He disapproved of my thinking too much and handed me a rose. I looked at it, you know. I told him, 'It's pretty, Joe. . . . Now think of all the thought that went into saying that.'

". . . Yes it is true that bad thinking over two or three hundred years has done a hell of a lot of harm and has done a hell of a lot of harm to processes other than thinking processes—I mean to emotional processes, affective processes. It does not follow from that—it's not *sequitur*—that thinking is therefore a bad thing. It does follow that bad thinking is a bad thing. There's some very bad thinking inside cybernetics already."

"Say some," I request, recalling Gregory's statement in *Steps: I think that cybernetics is the biggest bite out of the fruit of the Tree of Knowledge that mankind has taken in the last 2000 years. But most of such bites out of the apple have proved to be rather indigestible—usually for cybernetic reasons.*

"The whole thinking that goes with the words 'input' and 'output' is monstrously bad. It draws a line across the systemic structure. *Here* there's input and *there's* output, and it's me against the universe at once, the moment you draw that line.

"This actually throws away the whole cybernetic background for cybernetics, you know. The engineers have decided it is engineering. All they have to do, you see, is to cut off the circuit so that you have an 'input' on one end and an 'output' on the other, and those two never join up out in the environment. The input-output literature is very large, it's highly skilled engineering and all the rest of it, but it ignores the philosophy of the feedback.

"I'm not very happy with most of the application of games theory, because it tends to perpetuate the rules of the game as perceived at a given moment by the players—say the international game. The problem of the international game is how to change the rules, whereas game theory tends to give us solutions to the question of how to not lose according to the rules as they now are. Nobody knows a thing about changing the rules of the game.

Cybernetic ideas have got to inevitably revamp the whole of international politics, the whole of 'democracy'. Now, it's going to go off half-cocked and unripe *how* many times?—the idea of running the world by ideas, as distinct from ideals.

"I think there is a sort of spot of hope, something which is more than just fashion, in the amount of systems-theoretical talk one can have and have it half-way understood. This just wasn't so a very little while ago.

"We made a film in '49 at Langley-Porter Clinic of the fact that the minor patterns of interchange in a family are the major sources of mental illness. And nobody in '49 could look at that film; the professionals just could not see it. They were still really believing that mental illness was due to single major traumata. 'The child got left in the closet with the big dog.' It's linear thinking: you've got to find an identifiable cause for an identifiable effect. And the argument cannot spread backward the way cholera spreads forwards. When you get them spreading both ways, then you can begin thinking about circuits—indeed circuits become inevitable."

I'm still getting used to the way Gregory uses the term 'circuit'. It's appealing to me because it is at once more general than 'feedback loops', more accurate somehow, and more open-system. It implies shimmering networks (of what? . . . of influence, I guess) which may be traced in part but never really isolated. It sounds as if it can include cycles of interactive learning (student teaches the teacher to teach the student better), of material (flesh to ashes to flesh), of slow recurrence (every so often an ice age stresses the system), of standard homeostatic feedback (the chilled body shivers until warm), and of observer interference (the watched porpoise bedevils his observer). Without circuit, without continual self-corrective adjustment, is no life.

Paradoxical Learning

BESIDES CIRCUIT the other principal realm of cybernetics is the hierarchial relation of part to whole, trees to forest, steps up the meta-ladder of increasing abstraction and wider relevance, where at each level are fewer understandings and grander. At the top, sings atheist Bateson, "One is One and all alone and ever more shall be so."

He made a major contribution in the understanding of meta-relations with his concept of Deutero-Learning (or Learning II). The sequence goes thus . . . Learning 0 is the simple response to a stimulus. Learning I is the understanding of a connection—as dogs learn to salivate at the Pavlovian bell. Learning II, Deutero-Learning, is "learning to learn", becoming able to classify contexts and be mobile among them. Learning III, says Gregory, enters the domain of the mystics, where our biggest paradoxes resolve, where language can scarcely follow.

On his work in the '60s with porpoises in the Virgin Islands and Hawaii he reports, "Porpoises are capable of Deutero-Learning, we verified that. It's one of the few things we did get on them. The trainer was instructed not to reward the porpoise with a fish unless she—the porpoise was a female—did something, quote, *new*. The porpoise would come out of the holding tank and would go through two-thirds of the 15-minute session doing what had been rewarded in the last session, and then would more or less accidentally do something, quote, *new*. The trainer would reward that, and then the next session she'd spend two-thirds of the time doing *that*."

"Between the fourteenth and fifteenth session the porpoise got awfully excited in the holding tank, slapping around. She came on stage for the fifteenth session and did twelve new things one after another, some of which nobody'd ever seen at all in that species. She'd got the idea," chortling. "It's a nice case of the pressure of contradiction making her jump a level."

I try to imagine the porpoise-view of those sessions: I'm a smart lady porpoise, I've learned lots of tricks, and I'm learning a new one now, but things are going crazy. I swim a circle on my back, and the trainer gives me a fish. Got it. I skillfully swim another circle. No fish. Maybe I swam in the wrong direction, the wrong place, the wrong speed. I try all the variations. No fish! Maybe the trainer's not paying attention. I splash him once. A fish! I splash him again. No fish. What the *hell's* going on?

"A paradox," Gregory told his class, "is a contradiction in which you take sides—both sides. Each half of the paradox proposes the other. I think it is so that if you sweat out one of these paradoxes you embark on a sort of voyage, which may include hallucinations and trance and all that sort of stuff. But you come out knowing something you didn't know before, something about the nature of where you are in the universe."

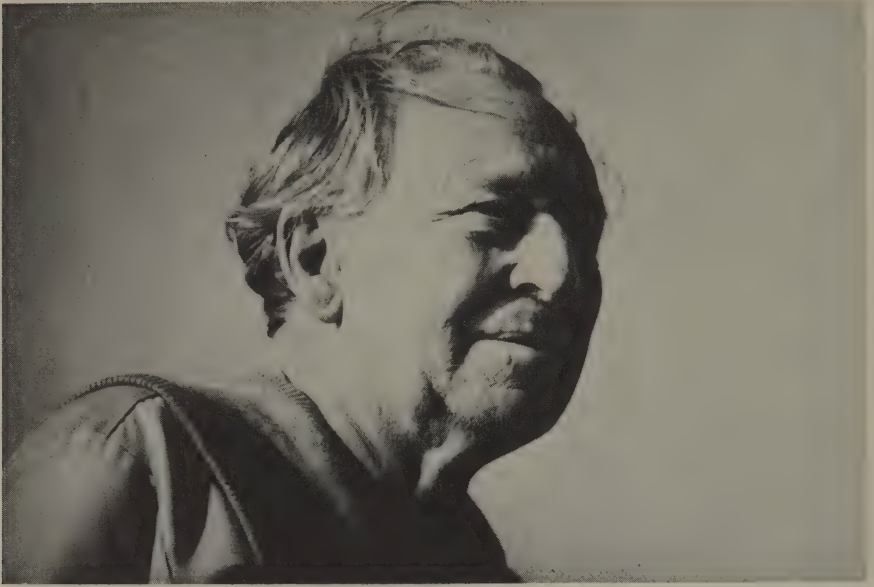
"*A man without a God*, quoth I from Herb Caen's San Francisco **Chronicle** column, "*is like a fish without a bicycle.*"

One of the students commented about the avoidance of paradox. "I had this incredible argument last night with an anthropologist who said to me emphatically that to try and cut down on your assumptions and try to see reality more clearly is absolutely nonfunctional. What you have to do is you have to see reality in terms of your *goals*. You're aware that you're biased in your perceptions; as long as your biases are consistent with your goals, that's just hunky dory."

"I think he's insane," said Gregory faintly. "This is, I think, the insanity of Twentieth Century America, the Twentieth Century Occident."

He elaborated later: "We are caught in a whole set of things—of which the most respectable is purpose and the least respectable I suppose is racial intolerance. All these definitions of self as over *against* other people or the environment—they depend upon not riding with the contradictions.

"You have a paradoxical situation, as between love and hate, in which both love and hate are going to be there. You make a choice



of one of those, be it either love or hate to the exclusion of the other, and from there on you're what E E Cummings calls a

pu
rpositive pu
nk

Purpose is the exclusion of one half of a Hegelian dialectic, as opposed to clinging to the dialectic and going on to the next synthesis whatever it might be."

I want some examples.

"We have various ways of life. Women, it seems, are different from men. The most ancient sex difference I suppose is the difference between one egg and a million spermatazoa. All sensible organisms, both plant and animal (with the exception of orchids), have decided this is how it should be, that the female principle should be single and carefully preserved and the male principle should be multiple and squandered. Mm hm.

“Now this has certain difficulties you know, because the men want to squander and the women want to match their unique eggery and think it would be nice to have a unique man. The problem is how do you ride with the dichotomy. God defend you if you settle for one side to the exclusion of the other. Then you get the situation in which either the men go feminine or the women go masculine, et cetera, et cetera. These all being, really, artifacts of somebody taking a shortcut.”

If I understand him right, trying to force strenuous monogamy or its opposite denies the healthy paradox at the heart of the matter. Rational purpose serving only its own convenience or plan—I want nature *my way*—asks for increasing trouble, the pathology of insistent control and guaranteed frustration, causing *more* insistent control, etc.

Gregory: “There are two forms of colonial administration. There is that form of colonial administration which says that the natives have got to be like the colonists. This is missionary endeavor, all that, and becomes a tyranny. The other form of colonial administration says that the natives have got to be like themselves and had better not change. ‘They have such a beautiful sense of rhythm.’ Then poetry freezes and everything dies and the flowers can’t make seed and nothing goes. So neither of these will do. To do either becomes imperialism.”

I ask how you choose, then.

Slowly: “The truth which is important is not a truth of preference, it’s a truth of complexity . . . of a total eco-interactive on-going web . . . in which we dance, which is the dance of Shiva. You know, the whole of good and evil gets wrapped up in the dance of Shiva. And in ancient Hebrew good-and-evil is a single word meaning ‘everything’.”

I ask him, “Relationship without preference works how?”

“Only preference for its complexity.”



A year passes.

Epilog I

The Evolutionary Idea

(December, 1973)

CYBERNETICS IS NO EASY SUBJECT to promote because there's no decent introductory book. The best initial source still is the man who coined the word, Norbert Weiner (*Cybernetics*, 1948, 1961, 212 pp., \$2.45, MIT Press; and *The Human Use of Human Beings*, 1950, 1954, 288 pp., \$1.45, Avon Books). Another good old one is Miller, Galanter, Pribram, *Plans and the Structure of Behavior*, 1960, 226 pp., \$10, Holt, Rinehart & Winston. Ross Ashby is the most functional by far. He's also formal and splendid and difficult; bring familiarity with algebra to *Introduction to Cybernetics* (1958, 295 pp., \$3.25, Barnes & Noble) and *Design for a Brain* (1952, 1960, 286 pp., \$3.25, Barnes & Noble).

There is an introductory cybernetics book under way organized by Heinz Von Foerster, an Austrian physicist who attended and edited the proceedings of the Macy Foundation meetings that started it all. The work is a collaborative effort with colleagues and students. Persons interested in this project can write to "The Cybernetics of Cybernetics", 216 EERL, University of Illinois, Urbana, Illinois 61801.

The healthiest display I've seen of the cybernetic tool in use is Gregory's *Steps to an Ecology of Mind*. As you might guess there's a lot more going on in the book and in his mind than what

I've touched in the Paradox article, and none of it is static. So I discovered while revisiting Santa Cruz last week, almost exactly a year after my first interview with him.

He and Lois and Nora are living at Cowell College on the UCSC campus now, reserving Big Sur for summer use. "John," reports Gregory, "is babysitting a ranch in British Columbia, on a little island with a population of ten or fifteen people I gather. He seems to like it; he says it's hard. The wolves got his dog the other day." Gregory's major news about himself is a book in the works titled **The Evolutionary Idea**.

"You will observe the name is double-barreled, because we are talking about the evolution of evolutionary theory, and we are talking about the thesis that what evolves *is* ideas. The Theory of Evolution's all been set up in terms of the survival of organisms—species, subspecies, mutants, families, but essentially aggregates of protoplasm.

"If the idea of having one eye on each side of your nose lasts longer than the idea of three eyes—one in your forehead and one on each side—then the one which lasts longer lasts longer. Natural selection does not deal with you, who obviously don't last very long, it deals with biological ideas in genomes—programs. The unit of evolution is ideas, it's not organisms."

"The field of evolution is what?" I inquire.

"The field of evolution is the same as the field of learning," he says, and goes on to detail the formal identity between stochastic learning and evolutionary adaptation. All this makes me eager to compare Gregory's forthcoming book with the best existing book on evolutionary theory, Garrett Hardin's **Nature and Man's Fate** (1959, 320 pp., \$1.95, New American Library).

Gregory's class this year is a large lecture course which delights him. The section leaders are not the usual graduate students but all are "grown up" with expertise of their own—a tidepool zoologist, a molecular geneticist, a self-unfrosted Jesuit priest, etc.

"Oh God, I've such good students. . . . I set them the assignment: 'Obtain a dead organism, and from what you can *see* in it derive

arguments to show that it's an information-processing entity.' For which you have to deal, obviously, with things like its symmetry, the fact that nothing is rigid in its structure, that every, quote, 'straight line' is in fact a self-corrected straight line—it's a wobble. . . . Completely innocent papers . . ." (He means that it often comes as news to the students that an octopus is not a sea mammal or that the "petal" of a sunflower is in fact a whole flower.)

Formulations I boldly reported in the Paradox article are already melting into other shapes. The Double Bind concept was always stated in terms of Set Theory, but now Gregory's mathematical interest is migrating to Group Theory. "The difference between a set and a group being that the members of a group are *generated* one from another, whereas a set is a list. Group Theory is a very elegant little subject. It has a math of meta-relations about permutation and combination. Most of atomic physics and things like this depend upon it nowadays. The Periodic Table of the Elements is essentially Group Theoretical." [Reportedly a new book by Paul Watzlavick called **Change** (1974, \$7.95, W.W. Norton) addresses communication problems in Group-Theoretical terms.]

I asked Gregory what he was thinking about "circuit" these days and was told, oh, nothing new, except that "circuit" seemed to imply narrow pathways of transmission that might hardly be necessary to explain how a system lived. The notion of "field" might work better as a theoretical base.

For a tour of the full range of Bateson's contributions you can go to no better place than his books. In backward order, they are:

Our Own Metaphor—Report of the Wenner-Gren Conference on the Effects of Conscious Purpose on Human Adaptation (organized by Gregory Bateson), Mary Catherine Bateson, 1972, \$8.95, Knopf.

Perceval's Narrative—A Patient's Account of His Psychosis, 1830-1832, by John Perceval, edited by Gregory Bateson, 1961, \$8.50, Stanford University Press.

Naven—A Survey of the Problems Suggested by a Composite Picture of the Culture of a New Guinea Tribe Drawn from Three Points of View, 1958 2d ed. (1936), \$3.25, Stanford University Press.

Communication: The Social Matrix of Psychiatry (with Jurgen Ruesch), 1951, 1968, \$2.65, Norton.

Balinese Character: A Photographic Analysis (with Margaret Mead), 1942, 277 pp., New York Academy of Sciences.

I'd be interested to learn who all has been influenced by Bateson's work. I know R.D. Laing has. So has the cybernetic anthropologist Roy Rappaport. (The quote at the beginning of *Paradox* is from Rappaport's paper, "Sanctity and Adaptation". He has written a book on the balancing warfare of two New Guinea tribes titled **Pigs for the Ancestors—Ritual in the Ecology of a New Guinea People** (1968, \$2.95, Yale University Press), and is preparing a book about "maladaptation"—a term that sets my fancy dancing.)

As a Bateson enthusiast and a publisher I'll be printing sundry papers, speculation, gossip, tidbits, letters, etc. on cybernetics (well, organic cybernetics) in the periodic supplement to the revived **Whole Earth Catalog**. Write, if you like, to "The COEVOLUTION Quarterly", Box 428, Sausalito, California 94965.

And now, to pursue the "special case" of machine cybernetics—computers and computer science—the sovereign domain of rational purpose, of explicit goal-directed behavior. Machines do only what you tell them. There is no paralinguistic communication with a computer.

Fanatic Life and Symbolic Death Among the Computer Bums

READY OR NOT, computers are coming to the people.

That's good news, maybe the best since psychedelics. It's way off the track of the "Computers—Threat or Menace?" school of liberal criticism but surprisingly in line with the romantic fantasies of the fore-fathers of the science such as Norbert Wiener, Warren McCulloch, J C R Licklider, John Von Neumann, and Vannevar Bush.

The trend owes its health to an odd array of influences: The youthful fervor and firm dis-Establishmentarianism of the freaks who design computer science; an astonishingly enlightened research program from the very top of the Defense Department; an unexpected market-flanking movement by the manufacturers of small calculating machines; and an irrepressible midnight phenomenon known as Spacewar.

Ah, Spacewar. Reliably, at any night-time moment (i.e. non-business hours) in North America hundreds of computer technicians are effectively out of their bodies, computer-projected onto cathode ray tube display screens, locked in life-or-death space combat for hours at a time, ruining their eyes, numbing their fingers in frenzied mashing of control buttons, joyously slaying their friends and wasting their employers' valuable computer time. Something basic is going on.

```

7c
7c
.8 578
WELCOME TO SPACEWAR.
HOW MANY SHIPS? MAXIMUM IS 5      5
THE "STANDARD" GAME IS:
1 CONSOLE, 2 TORPEDO TUBES, KILLER SCORING,
NO PARTIAL DAMAGE, NO HYPERSPACE, KILLER SUM.
SHIPS START IN STANDARD POSITIONS.
TYPE Y TO GET A STANDARD GAME: n
SECOND CONSOLE? NUMBER ELSE RETURN:
HOW MANY SPACE SHIPS DO YOU WANT?
CHOOSE FROM 2 TO 5      4
PARTIAL DAMAGE? y
DISPLAY SCORES? y
TWO TORPEDO TUBES? y
KILLER SCORE? n
HYPERSPACE? y
"RANDOM" STARTING POSITIONS? n

```

Entry to Spacewar on graphic terminal at Stanford's Artificial Intelligence Lab.

Rudimentary Spacewar consists of two humans, two sets of control buttons or joysticks, one TV-like display and one computer. Two spaceships are displayed in motion on the screen, controllable for thrust, yaw, pitch and the firing of torpedoes. Whenever a spaceship and torpedo meet, they disappear in an attractive explosion. That's the original version invented in 1962 at MIT by Steve Russell. (More on him in a moment.)

October, 1972, 8 p.m., at Stanford's Artificial Intelligence (AI) Laboratory, moonlit and remote in the foothills above Palo Alto, California. Two dozen of us are jammed in a semi-dark console room just off the main hall containing AI's huge PDP-10 computer. AI's Head System Programmer and most avid Spacewar nut, Ralph Gorin, faces a display screen which says only:

THIS CONSOLE AVAILABLE.

He logs in on the keyboard with his initials: *click clickclickclick click:*

L 1, REG

CSD FALL PICNIC. SATURDAY. 11 AM
IN FLOOD PARK . . .

He interrupts further announcements, including one about the "First Intergalactic Spacewar Olympics" at 8 PM, with: *click* ("run") *clickclickclick* ("Space War Ralph") *click* ("do it").

R SWR.

WELCOME TO SPACEWAR.

HOW MANY SHIPS? MAXIMUM IS 5.

Click: 5 (Five players. This is for the first familiarization battles in the Spacewar Olympics, initiated by me and sponsored [beer & prizes] by **Rolling Stone**. Friends, I won't be able to explain every computer-technical term that comes by. Fortunately you don't need them to get the gist of what's happening.)

KEYBOARD BUTTONS? (ELSE REGULAR). TYPE Y OR N.

"Yes." *Click:* Y

THE STANDARD GAME IS:

1 CONSOLE, 2 TORPEDO TUBES, (NORMAL) SCORING,
NO PARTIAL DAMAGE, NO HYPERSPACE, KILLER SUN.
SHIPS START IN STANDARD POSITIONS. TYPE Y TO
GET A STANDARD GAME.

Ralph wants other features. "No." *Click:* N

HOW MANY SPACE MINES DO YOU WANT?
CHOOSE FROM \emptyset TO 4.

Click: 4

PARTIAL DAMAGE?

Click: N

DISPLAY SCORES?

Click: Y

TWO TORPEDO TUBES?

Click: Y

HYPERSPACE?

Click: N

RANDOM STARTING POSITIONS?

Click: Y

Immediately the screen goes dark and then displays: Five different spaceships, each with a dot indicating torpedo tubes are loaded, five scores, each at \emptyset , a convincing starfield, and four space mines



Ralph Gorin, nearest the display tube, warms up Spacewar contestants. Rocket controls are visible on knee of player at left—four buttons: one for thrust, one for torpedoes, one each for turn to the left and to the right.



Intergalactic Spacewar Olympics Free-For-All under way. Executive Officer Les Earnest is at upper right.

orbiting around a central sun, toward which the spaceships are starting to fall at a correctly accelerating rate.

Players seize the five sets of control buttons, find their spaceship persona on the screen, and simultaneously: turn and fire toward any nearby still-helpless spaceships, hit the thrust button to initiate orbit before being slurped by the killer sun, and evade or shoot down any incoming enemy torpedoes or orbiting mines. After two torpedoes are fired, each ship has a three-second unarmed "reloading" time. Fired torpedoes last nine seconds and then disappear.

As kills are made the scores start to change. +1 for a successful kill, -1 for being killed, +1 for being lone survivor of a battle. Personalities begin to establish themselves in the maneuvering spaceships. The pilot of the ship called POINTY FINS is a dead shot but panics easily in crossfire. ROUND BACK tries to avoid early dueling and routinely fires two torpedoes "around the universe" (off the screen, so they reappear lethally unexpected from the opposite side).



1 (above left)

Gravitating toward the central "sun" from "standard starting positions" next to their accumulative scores are (from the top, clockwise) POINTY FINS, ROUND BACK, FLAT BACK, BIRDIE, and FUNNY FINS. BIRDIE is firing a torpedo and applying thrust toward FUNNY FINS. FLAT BACK is firing at ROUND BACK. Four orbiting space mines are visible on the left.

2 (below left)

A moment later, POINTY FINS, FLAT BACK, and their torpedoes are converging on ROUND BACK. FUNNY FINS is still applying no thrust and may "slurp" into the sun if he doesn't drive for orbit.



3 Caught in crossfire, ROUND BACK explodes (his score changes from 2 to 1; FLAT BACK, from -1 to 0). BIRDIE fires at FUNNY FINS. POINTY FINS and FLAT BACK save their torps for closer range.

BIRDIE drives for the sun and a fast orbit, has excellent agility in sensing and facing toward hazard. FUNNY FINS shouts a lot, singling out individual opponents. FLAT BACK is silent and maintains an uncanny field-sense of the whole battlesky, impervious to surprise attack.

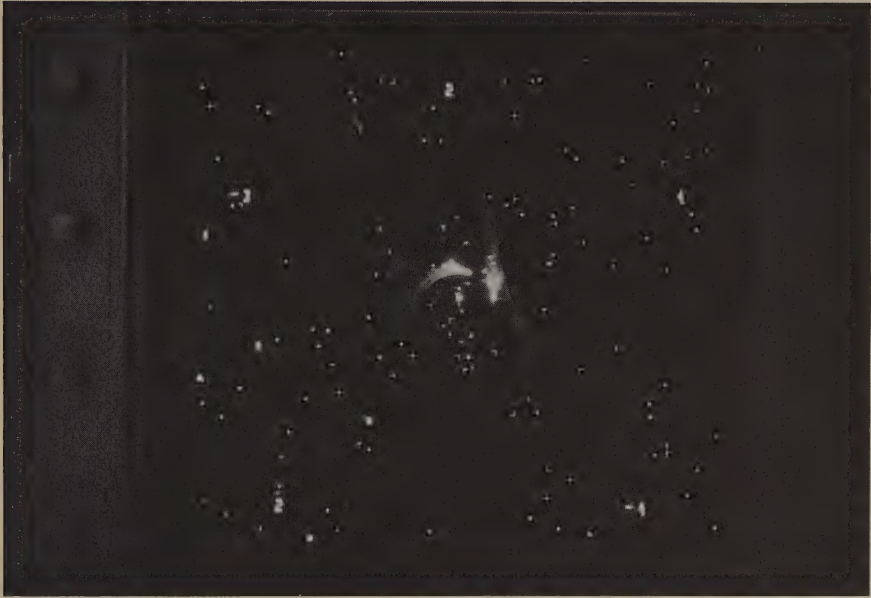
A game is over when only one or no survivors are displayed. The screen then blanks out, counts down 5-4-3-2-1, and redisplay a new battle with ships at new random positions equidistant from the sun and showing scores accumulative from previous games. A spaceship that is killed early in a battle will reincarnate after 16 seconds and rejoin the fray, so that a single battle may last up to five minutes with a weak player perishing several times in it.

- 4 *Death of FUNNY FINS (-2 to -3, BIRDIE gains a point). POINTY FINS and FLAT BACK fire frantically at each other.*



6 (below right)

POINTY FINS accelerates past sun, turning back toward BIRDIE, who is thrusting toward the edge of the screen for an attack "around the universe".



5 *Death of FLAT BACK. POINTY FINS survives miraculously. BIRDIE turns and thrusts, not fast enough.*



The twenty or so raucous competitors in the Spacewar Olympics quickly organize three events: Five-Player Free-For-All, Team Competition (two against two), and Singles Competition. The Executive Officer of the AI Project, Les Earnest, who kindly okayed these Olympics and their visibility, is found to have no immediate function and is sent out for beer.

The setting and decor at AI is Modern Mad Scientist—long hallways and cubicles and large windowless rooms, brutal fluorescent light, enormous machines humming and clattering, robots on wheels, scurrying arcane technicians. And also, posters and announcements against the Vietnam War and Richard Nixon, computer print-out photos of girlfriends, a hallway-long banner **SOLVING TODAY'S PROBLEMS TOMORROW**, and signs on every door in Tolkien's elvish Fëanorian script—the director's office is *Imladris*, the coffee room *The Prancing Pony*, the computer room *Mordor*. And there's a lot of hair on those technicians, and nobody seems to be telling them where to scurry.

The games progress. A tape recorder kibitzes on the first round of Team Competition, four ships twisting, converging, evading, exploding:

"Where am I? Where am I?" *click clickclickclickclick*

"Agh!" *clickclickclick clickclick*

"Glitch." *clickclick*

"OK, I won't shoot." *clickclickclick*

"Good work Tovar. Revenge." *clickclick clickclick*

"Cease fire." *click clickclick*

"Ohhhhh NO! You killed me, Tovar."

"I'm sorry." *clickclickclick*

"Being partners means never having to say you're sorry."
clickclickclick

"Get him! Get the mother!" *clickclickclickclickclick*

"Sacrifice." *clickclick click*

"Lemme get in orbit." *clickclick*

"Way to dodge." *click clickclickclick*

"Awshit."

"Get tough now." *clickclickclick*

“The other guy was out of torps. I knew it and waited till I got a good shot.” *clickclick*

“A beaut. O lord.” *clickclickclick*

“I shot him but then I slurped.” *clickclick clickclick*

“Oooo!”

“We win! Tovar and Rem!”

Correct. Tovar and Rem won the Team Competition (Rem is how Robert E. Maas is known to the computer and thence to his friends). Bruce Baumgart, who by day builds sensing intelligence into a robot vehicle, won the Free-For-All with a powerhouse performance. And slim Tovar took the Singles.

Meanwhile, your photographer, Annie, was tugged all over the lab to see the hand-eye rig, the number halftone printer, various spectacular geometric display hacks, computer music programs, the color video image maker . . . Four intense hours, much frenzy and skilled concerted action, a fifteen-ring circus in ten different directions, the most bzz-bzz-busy scene I’ve been around since Merry Prankster Acid Tests . . . and really it’s just a normal night at the AI Project, at any suitably hairy computer research project. Something basic . . .

These are heads, most of them. Half or more of computer science is heads. But that’s not it. The rest of the counter-culture is laid low and back these days, showing none of this kind of zeal. What, then?

The Hackers

I’M GUESSING THAT ALAN KAY (to be introduced formally in a moment) has a line on it, defining the standard Computer Bum: “About as straight as you’d expect hot rodders to look. It’s that kind of fanaticism. A true hacker is not a group person. He’s a person who loves to stay up all night, he and the machine in a love-hate relationship . . . They’re kids who tended to be brilliant but not very interested in conventional goals. And computing is just a



Bruce Baumgart takes his robot on a tour of AI's computer room. All hardware visible is part of the PDP-10.

fabulous place for that, because it's a place where you don't have to be a Ph.D. or anything else. It's a place where you can still be an artisan. People are willing to pay you if you're any good at all, and you have plenty of time for screwing around."

The hackers are the technicians of this science—"It's a term of derision and also the ultimate compliment." They are the ones who translate human demands into code that the machines can understand and act on. They are legion. Fanatics with a potent new toy. A mobile new-found elite, with its own apparatus, language and character, its own legends and humor. Magnificent men with their flying machines, scouting a leading edge of technology which has an odd softness to it; outlaw country, where rules are not decree or routine so much as the starker demands of what's possible.

A young science travels where the young take it. The wiser computer research directors have learned that *not* trusting their young programmers with major responsibility can lead immediately to no research. AI is one of perhaps several dozen computer research

centers that are flourishing with their young, some of them with no more formal education than they got at the local Free School. I'm talking to Les Earnest, the gent who went for beer. He's tall, swarthy, has a black and white striped beard, looks like a Sufi athlete. He's telling me about what else people build here besides refinements of Spacewar. There's a speech recognition project. There's the hand-eye project, in which the computer is learning to see and visually correct its robot functions. There's work on symbolic computation and grammatical inference. Work with autistic children—"trying to get them to relate to computers first, and then later to people. This seems to be successful in part because many of these children think of themselves as machines. You can encourage them to interact in a game with the machines."

There's work in machine translation of natural language, on mathematical theory of computation, on Mars. "Transforming images shot by the Mariner satellite taken at different times—taking out the differences in viewpoint, taking out the effects of the different sun angles, so that you can compare two images and see what's changed. In fact you can see places where some dark material on the surface has moved, probably due to a wind storm."

Who do I talk to about seeing one of these pictures? "Lynn Quam is one of our principal Martians . . . He's one of our relatively straight people. That is, he lives in only a five-person commune."

Another window on the interests of AI and the hackers is a posted print-out of the file of AI's system programs, some 250 elaborate routines available. Scanning: Hand Eye Monitor . . . Go Game . . . DPY Hack Broom Balancing . . . Comparison Portion of Soup . . . Retrieves Selected AP News Stories . . . Display Hack . . . Mad Doctor . . . New TV Editor . . . Fortune Cookie Program . . . Another Display Hack . . . Kalah Game . . . Oh Where, Oh Where Has My Little Job Gone . . . Paranoid Model . . . Pruning Program . . . The Wonderful News Program . . . Old Spacewar . . . New Spacewar . . . Send Everyone a Message . . . Old Version of Daemon . . . Tell Everyone the System Is Going Down . . . Music Compiler Sort Of . . . New Music Compiler . . .

MACRU	DMP	REG	ASSEMBLER
MACT06	DMP	RPH	READ PROJECT MAC DECTAPES (IF YOU'RE VERY LUCKY)
MAGTST	DMP	GJG	MAGTAPE TEST
MANLST	DMP	KKP	MANUAL UPDATE?
MATHLA	DMP	WD	MATH LAB (SYMBOLIC CALCULATION PROGRAM)
MES	DMP	RPH	SEND A MESSAGE TO ONE TTY
MIX	DMP	RES	MIX INTERPRETER (KNUTH'S MAGIC MACHINE)
MIXAL	DMP	RES	MIX ASSEMBLER
MLISP	DMP	DAV	MLISP
MLISP2	DMP	WD	NEW IMPROVED MLISP
MLISPC	DMP	DAV	COMPILING VERSION OF MLISP
MONITR	DMP	DCS	PEEKS AT SAIL JOBS AND TYPES OUT STORAGE USAGE INFO
MONUSE	DMP	JAM	TYPE MONITOR STATISTICS
MULDIV	DMP		RANDOM DIAGNOSTIC, WON'T RUN
MUS10	DMP	MUS	PART OF MUSIC SYSTEM
NEWMUS	DMP	TVR	NEW MUSIC COMPILER (REPLACES MUS10)
NEWS	DMP	LES	THE WONDERFUL NEWS PROGRAM
NSAIL	DMP	DCS	NEW SAIL SYSTEM
OSAIL	DMP	DCS	OLD SAIL SYSTEM
P	DMP	RPH	FOONLY PLOT PROGRAM
P2P	DMP	RPH	PAPER TAPE DUPLICATOR
PACK	DMP	REM	FILE PACKING PROGRAM FOR NON-ASCII (HALF ASCII?) FILES
PAL	DMP	DCS	POP11 ASSEMBLER
PARRY	DMP	KMC	PARANOID MODEL
PC	DMP	RPH	FOONLY PC CARD LAYOUT
PCHECK	DMP	WD	PROOF CHECKER
PCP	DMP	RPH	FOONLY PLOT FOR PC
PETAL	DMP	DCS	DISPLAY HACK
PICTUR	DMP	TEO	TAKE TV PICTURES TO DISK OR LPT
PIP	DMP	DEC	VERY OLD CRUFTY FILE PUSHER, COMPLETELY REPLACED BY COPY
PIXPEN	DMP	RBN	DRAW ON III WITH LIGHT PEN
PLNR	DMP	RPO	MICRO PLANNER
PLTVEC	DMP	RBN	PLOT III DISPLAY BUFFER ON CALCOMP
PPSAV	DMP	FW	COPY DISPLAY PAGE PRINTER TO DISK
PRDIAG	DMP	DEC	LINE PRINTER DIAGNOSTIC
PROFIL	DMP	RES	SAIL EXECUTION PROFILE
PRUNE	DMP	RPH	PRUNING PROGRAM
PTYJOB	DMP	GJA	RUNS A JOB THRU A PTY, SAVING ALL OUTPUT
PUB	DMP	TES	DOCUMENT COMPILER
PUB2	DMP	TES	PUH PASS TWO
RAID	DMP	DCS	RAID
RECOV	DMP		DECTAPE RECOVERY
REDLCH	DMP	ACH	BACKUP FOR REDUCE
REDUCE	DMP	ACH	SYMBOLIC FORMULA MANIPULATION
REPENT	DMP	REG	DISPLAY HACK
RLISP	DMP	ACH	SYMBOLIC MODE SUBSET OF REDUCE
RPG	DMP	DCS	RPG PROGRAM
RSL	DMP	JHS	SERVICE LEVEL RESERVATION PROGRAM
RUNOFF	DMP	DEC	LISTING PROGRAM
SAIL	DMP	DCS	SAIL COMPILER
SAVE	DMP	DCS	OLD DISK-TAPE DUMP/RESTORE
SCORE	DMP	LCS	MUSIC COMPILER SORT OF

One page of five of the AI System Programs printout. Key-in the code on the left column and you get the program on your terminal.

Right, the music project. Les Earnest: "They're working with stereo and quadrophonic sound synthesized by the computer, in which you can control not only the sounds of the instruments but where they are located in space. You can spin them around your head or whatever. You can also vary the acoustics of the simulated room if you wish."

One of the graduate students at AI, Andy Moorer, later tells me of further heights of music instrumentation: "There's one guy at Utah who's an Enrico Caruso freak, with all these old scratchy 78 rpm Enrico Caruso records. He's been writing programs to take all the scratches out and to enhance the fidelity of the whole thing . . . There's another fellow who took the same Caruso records and wrote a program to eliminate the orchestral background from them. I don't know what good it is." A true hacker.

A distinction exists between low-rent and high-rent computer research, between preoccupation of support group (hackers) and of research group. The distinction blurs often. Les Earnest: "Sometimes it's hard to tell the difference between recreation and work, happily. We try to judge people not on how much time they waste but on what they accomplish over fairly long periods of time, like a half year to a year." He adds that Spacewar players "are more from the support groups than the research groups. The research groups tend to get their kicks out of research."

Spacewar is low-rent.

Spacewar

LOW-RENT . . . BUT pervasive. Alan Kay: “The game of Spacewar blossoms spontaneously wherever there is a graphics display connected to a computer.”

The first opportunity was at the Massachusetts Institute of Technology (MIT) Electrical Engineering Department back in 1961-1962. The earliest mini-computer, Digital Equipment Corporation’s PDP-1, was installed in the kludge room with a cathode ray tube display hooked on. (“Kludge”—any lash-up, often involving chewing gum, paper clips, scotch tape; it works if no one trips over a wire; unadaptable; a working mess.) There it was that Steve Russell and his fellow hackers Alan Kotek, Peter Samson and Dan Edwards introduced Spacewar to the world.

I phoned Russell at the sprawling old fabric mill in Maynard, Massachusetts, where Digital Equipment Corporation manufactures the most popular research and education computers on the market. Russell currently is a researcher for them working on man-machine interface problems—adapting computer nature to fit human nature. Back in 1962 he was a hacker, 23 or so, a math major two years out of Dartmouth working in the brand new field of computer science for John McCarthy at MIT.

His account of the invention of Spacewar is not only intriguing history, it’s the most sophisticated analysis of good game design I’ve ever run across—elegant work. But that’s in retrospect; back then it was just kids staying up all night.

“We had this brand new PDP-1,” Steve Russell recalls. “It was the first mini-computer, ridiculously inexpensive for its time. And it was just sitting there. It had a console typewriter that worked right, which was rare, and a paper tape reader, and a cathode ray tube display. [There had been CRT displays before, but primarily in the Air Defense System.] Somebody had built some little pattern-generating programs which made interesting patterns like a kaleidoscope. Not a very good demonstration. Here was this display

that could do all sorts of good things! So we started talking about it, figuring what would be interesting displays. We decided that probably, you could make a two-dimensional maneuvering sort of thing, and decided that naturally the obvious thing to do was spaceships.”

Naturally?

“I had just finished reading ‘Doc’ Smith’s **Lensman** series. He was some sort of scientist but he wrote this really dashing brand of science fiction. The details were very good and it had an excellent pace. His heroes had a strong tendency to get pursued by the villain across the galaxy and have to invent their way out of their problem while they were being pursued. That sort of action was the thing that suggested Spacewar. He had some very glowing descriptions of spaceship encounters and space fleet maneuvers.”

“Doc” Smith: *The Boise leaped upon the Nevian, every weapon aflame. But, as Costigan had expected, Nerado’s vessel was completely ready for any emergency. And, unlike her sister-ship, she was manned by scientists well-versed in the fundamental theory of the weapons with which they fought. Beams, rods and lances of energy flamed and flared; planes and pencils cut, slashed and stabbed; defensive screens glowed redly or flashed suddenly into intensely brilliant, coruscating incandescence. Crimson opacity struggled sullenly against a violet curtain of annihilation. Material projectiles and torpedoes were launched under full-beam control; only to be exploded harmlessly in mid-space, to be blasted into nothingness or to disappear innocuously against impenetrable polycyclic screens.*

—Triplanetary (1948)

Steve Russell: “By picking a world which people weren’t familiar with, we could alter a number of parameters of the world in the interests of making a good game and of making it possible to get it onto a computer. We made a great deal of compromises from some of our original grand plans in order to make it work well.

“One of the important things in Spacewar is the pace. It’s relatively fast-paced, and that makes it an interesting game. It seems to be a reasonable compromise between action—pushing buttons—and thought. Thought does help you, and there are some tactical considerations, but just plain fast reflexes also help.

“It was quite interesting to fiddle with the parameters, which of course I had to do to get it to be a really good game. By changing the parameters you could change it anywhere from essentially just random, where it was pure luck, to something where skill and experience counted above everything else. The normal choice is somewhere between those two. With Spacewar an experienced player can beat an amateur for maybe 20 to 50 games and then the amateur begins to win a little.”

The pride of any hacker with a new program is its “features.” Fresh forms of Spacewar with exotic new features proliferated. As Russell explains it, everything at MIT had priority over Spacewar, but it was an educational computer after all, and developing new programs (of Spacewar) was educational, and then those programs needed testing . . . The initial game of simply two spaceships and their torpedoes didn’t last long.

Gravity was introduced. Then Peter Samson wrote in the starfield with a program called “Expensive Planetarium” (MIT’s first text display had been called “Expensive Typewriter”). Russell: “Having a background was important to give some idea of range and so on. Our Spacewar did not have gravity affecting the torpedoes—our explanation was that they were photon bombs and that they weren’t affected by gravity. Subsequent versions on newer computers have got enough compute time so that they can afford to use gravity for the torpedoes, and that makes it a more interesting game.

“One of the other things I experimented with was putting a little more realism in it. The torpedoes in Spacewar go plodding along very reliably. I said, ‘Gee, that’s not real. Most real-world devices have some noise in them.’ So I put a little random error in the torpedoes. They wouldn’t always go quite the direction you aimed them, and they didn’t always go quite as far as you expected, and they didn’t go quite as fast as you expected. I thought it was kind of a neat idea, but everybody just *hated* it. And if you think about it, you’ll see that people take a great deal of effort to make sure that their guns and knives and other offensive weapons are the best they can get. That variation died very quickly.”

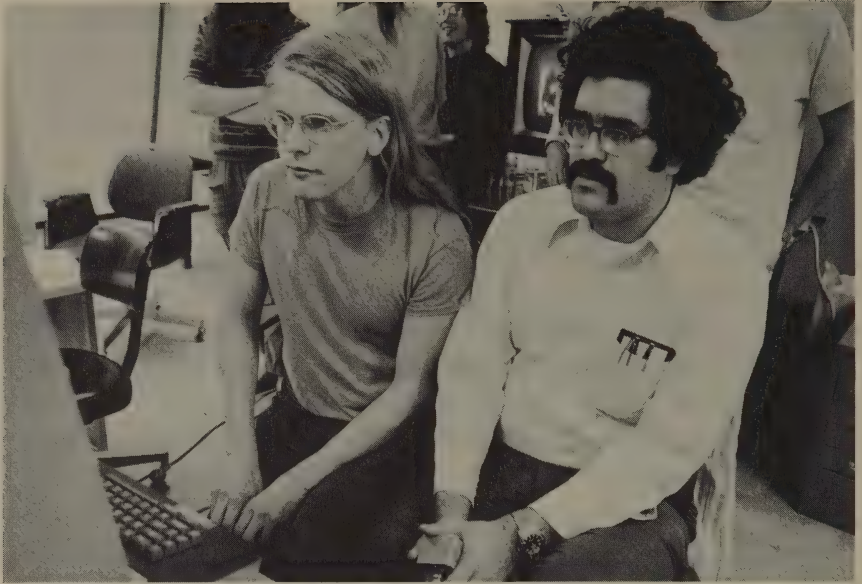
And then came a startling development called Hyperspace—when your situation got desperate you could push both turn buttons at once and go into hyperspace: disappear from the screen for a few seconds and then reappear at a random new position . . . maybe.

“Hyperspace was in within a month or so,” says Russell. “It’s a little controversial. Some people deplore it, and it’s fairly common to play games without it. . . . It was of course vital to put in problems with hyperspace. You know, when you come back into normal space from hyperspace, there is initially a small energy-well which looks amazingly like a star; if a torpedo is shot into that energy well, lo and behold the ship blows up. There is also a certain probability of blowing up as you finally break out of hyperspace. Our explanation was that these were the Mark One hyperfield generators and they hadn’t done really a thorough job of testing them—they had rushed them into the fleet. And unfortunately the energies that were being dissipated in the generators at breakout were juuust barely what they could handle. So the probability of the generator flying apart and completely killing the spaceship was noticeable on the first couple of uses, and after four uses it was only an even chance of surviving hyperspace. So it was something that you could use but it wasn’t something that you wanted to use.”

“Doc” Smith: Twenty-odd years before, when the then Dauntless and her crew were thrown out of a hyper-spatial tube and into that highly enigmatic Nth space, LaVerne Thorndyke had been Chief Technician. Mentor of Arisia found them, and put into the mind of Sir Austin Cardynge, mathematician extraordinary, the knowledge of how to find the way back to normal space. Thorndyke, working under nerve-shattering difficulties, had been in charge of building the machines which were to enable the vessel to return to her home space. He built them. She returned.

—Children of the Lens (1954)

Peter Deutsch, a colleague of Alan Kay, reminisces about the first Spacewar: “The programming of the thing was a remarkable tour de force, because the machine did not have a multiply or divide. The



Spacewar concentration. Bruce Baumgart and Ralph Gorin one on one.

way that the outline of the spaceship was rotated was by compiling a special-purpose program. Nice programming trick . . . Spacewar was not an outgrowth of any work on computer graphics, but it may have inspired some of it. That's speculation."

Albert Kuhfeld, writing in July, 1971, *Analog* magazine, reminisces:

The first few years of Spacewar at MIT were the best. The game was in a rough state, students were working their hearts out improving it, and the faculty was nodding benignly as they watched the students learning computer theory faster and more painlessly than they'd ever seen before. . . . And a background of real-time interactive programming was being built up that anybody in the school could draw on; one of the largest problems in the development of the game was learning how to talk to a computer program and have it answer back.

Within weeks of its invention Spacewar was spreading across the country to other computer research centers, who began adding their own wrinkles.

There was a variation called Minnesota Hyperspace in which you kept your position but became invisible; however if you applied thrust, your rocket flame could be seen . . . Score-keeping. Space mines. Partial damage—if hit in a fin you could not turn in that direction.

Then “2½-D” Spacewar, played on two consoles. Instead of being God viewing the whole battle, you’re a mere pilot with a view out the front of your spaceship and the difficult task of *finding* your enemy. (Perspective could be compressed so that even though far away the other ship would be large enough to see.)

Adding incentive, MIT introduced an electric shock to go with the explosion of your ship. A promising future is seen for sound effects. And now a few commercial versions of Spacewar—25 cents a game—are appearing in university coffee shops.

Steve Russell still dreams: “Something which I wanted to do is get some interesting sort of fleet action. There are some versions of Spacewar which allow multiple ships, but as far as I know no one has been sufficiently clever to set things up so there are ships with noticeably different characteristics that could fight in interesting combinations.”

John Lilly (of dolphin, acid, and biocomputer fame) tells a story that IBM once forbade the playing of Spacewar by IBM researchers. After a few suddenly uncreative months of joyless research the ban was rescinded. Apparently, frivolous Spacewar had been the medium of important experiments. (In every computer-business story I’ve ever heard, IBM invariably plays the heavy.)

Les Earnest at AI confirms the moral. For instance, at his lab the ingenious device for handling interactive graphics on the timeshared computer is called “Spacewar Mode” in honor of its origins.

Surprisingly, there have been relatively few Spacewar-like games invented. The most elaborate is a “Snoopy and the Red

Baron" game which involves flying your console like a biplane. But computer graphics as an area of research has mushroomed. The field is too wide and deep and engrossing for me to report here. It's an art form waiting for artists, a consciousness form waiting for mystics.

All right, one sample: the vision helmet designed by Ivan Sutherland at Harvard. The helmet covers the front of your face with special goggles that are tiny computer-driven TV screens. They present you with a visual space in which you can move. The computer monitors where your head moves and alters what you see accordingly. In the projected reality you can look around, you can look behind you, you can move toward things and through them. You can furthermore change parameters. Your head goes forward a foot and in the vision you soar a hundred yards. Or you can travel in exaggerated relativistic space, so that if you lunge at something it *bends away*. Become a geometric point; become enormous; live out Olaf Stapledon's **Star Maker**.

In all the various computer centers there are innumerable dazzling graphic sensations, but the only one you find everywhere is Spacewar. Nobody has satisfactorily explained the game's fascination, the total concentration it inspires, the addiction it feeds. In my opinion its major attraction is the intensity of conflict, the sheer personal combativeness involved, plus the just-barely-graspable swarm of concerns that must be held in mind simultaneously to fight well.

Alan Kay assesses it from the computer design standpoint: "It hits one the way any good interactive program does. It's something you can step right up to. You really become a part of the particular thing that you're doing. You have a lot of kinesthetic sense . . . Spacewar has propagated pretty much through the ARPA community and not much anywhere else, because most of computer graphics work is done in ARPA."

ARPA

THE LETTERS STAND for Advanced Research Projects Agency, one of the rare success stories of Government action. Poetically enough it owes its origin to real spacewar. After Russia's Sputnik humiliated the U.S. in the middle of the fifties, America came back hard with the Mercury Program, John Glenn and all that, crash-funded through a new agency directly under the Secretary of Defense—ARPA.

When the U.S. space program was moved out of the military to become NASA, ARPA was left with a lot of funding momentum and not much program. Into this vacuum stepped JCR Licklider, among others, with the suggestion that since the Defense Department was the world's largest user of computers, it would do well to support large-scale basic research in computer science. It was ARPA's policy in those days that basic research be neither secret nor limited to military purposes, which boded well for exploration in an information-medium like computers.

So in 1963 a fraction of ARPA's budget, some \$5 to 8 million, went into a program called IPT (Information Processing Techniques) under the initial direction of Licklider and then of a 26-year-old named Ivan Sutherland. Sutherland, the developer of "Sketchpad" at MIT, gave the agency its bias toward interactive graphics and its commitment to "blue sky mode" research. The next director, Bob Taylor, then 32, doubled IPT's budget (while ARPA's overall budget was shrinking) and administered a five-year golden age in computer research.

The beauty was, that being at the very top of the Defense Establishment, the agency had little Congressional scrutiny and little bureaucratic pettiness to contend with. There was instead clear and immediate individual responsibility, able to take creative chances and protect long-term deep-goal projects.

Alan Kay: "90 percent of all good things that I can think of that have been done in computer science have been done funded by that

agency. Chances that they would have been funded elsewhere are very low. The basic ARPA idea is that you find good people and you give them a lot of money and then you step back. If they don't do good things in three years they get dropped—where 'good' is very much related to new or interesting."

Legends abound from early ARPA days, full of freedom and weirdness. Here's one of many from Project MAC (Multiple Access Computer) days. Alan Kay: "They had a thing on the PDP-1 called 'The Unknown Glitch' ["Glitch"—a kink, a less-than-fatal but irritating fuck-up]. They used to program the thing either in direct machine code, direct octal, or in DDT. In the early days it was a paper-tape machine. It was painful to assemble stuff, so they never listed out the programs. The programs and stuff just lived in there, just raw seething octal code. And one of the guys wrote a program called 'The Unknown Glitch,' which at random intervals would wake up, print out **I AM THE UNKNOWN GLITCH. CATCH ME IF YOU CAN**, and then it would relocate itself somewhere else in core memory, set a clock interrupt, and go back to sleep. There was no way to find it."

One of the accomplishments of ARPA-funded research during this time was time-sharing. Time-sharing is a routine technique that allows a large number of users to sit down "on-line" with a computer as if each were all alone with it. Naturally, time-sharing was of no interest to computer manufacturers like IBM since it meant drastically more efficient use of their hardware and they were still a long way from saturating their market with old technology. Only after ARPA had developed time-sharing *and* its research-center market in the mid-sixties did the manufacturers adopt the innovation and make it available to the rest of us. There's a political/economic moral in this story somewhere; I think it has to do with the benefits of variant parallel systems.

ARPA is a rare but not completely isolated instance of enlightened Government research. For years the Office of Naval Research funded the most outstanding work in pure mathematics without any hope of benefits for war-making.

In 1969 the political climate at ARPA changed with the passing into law of the Mansfield Amendment, which required that military-funded research serve only clearly military goals and answer to Congress on the matter. In other words, the Defense Department was forbidden to try to obsolete itself. Bob Taylor departed ARPA.

The next (and current) director at ARPA-IPT was Larry Roberts, a brilliant researcher who had developed the first "3-D" vision programs. His major project has been getting the ARPA Network up. (*Up* around computers means "working", the opposite of *down* or *crashed*.) The dream for the Net was that researchers at widely separated facilities could share special resources, dip into each other's files, and even work on-line together on design problems too complex to solve alone.

At present some 20 major computer centers are linked on the two-year-old ARPA Net. Traffic on the Net has been very slow, due to delays and difficulties of translation between different computers and divergent projects. Use has recently begun to increase as researchers travel from center to center and want to keep in touch with home base, and as more tantalizing sharable resources come available. How Net usage will evolve is uncertain. There's a curious mix of theoretical fascination and operational resistance around the scheme. The resistance may have something to do with reluctances about equipping a future Big Brother and his Central Computer. The fascination resides in the thorough rightness of computers as communication instruments, which implies some revolutions.

One popular new feature on the Net is AI's Associated Press service. From anywhere on the Net you can log in and get the news that's coming live over the wire or ask for all the items on a particular subject that have come in during the last 24 hours. Plus a fortune cookie. Project that to household terminals, and so much for newspapers (in present form).

Since huge quantities of information can be computer-digitalized and transmitted, music researchers could, for example, swap records over the Net with "essentially perfect fidelity." So much for record stores (in present form).

I asked Alan Kay if Spacewar had been played over the Net. He said it's possible. I asked if there'd been international Spacewar yet, and was told a story. "There's a problem there of sending code groups. When Greenblatt's chess problem reigned supreme, they tried to play one of the Russian chess programs. Instead of doing it by mail or using an international phone call they decided to do it by amateur radio. There's this Federal statute against transmitting code groups of any kind, including chess moves. It took a long time to straighten that out. There was eventual communication with the Russians through a ham link in Switzerland."

True hackers. Who won?

"Greenblatt's program won. It's called 'Mack Hack 6.' It was a Class C player, and has since been superceded by a couple of other programs."

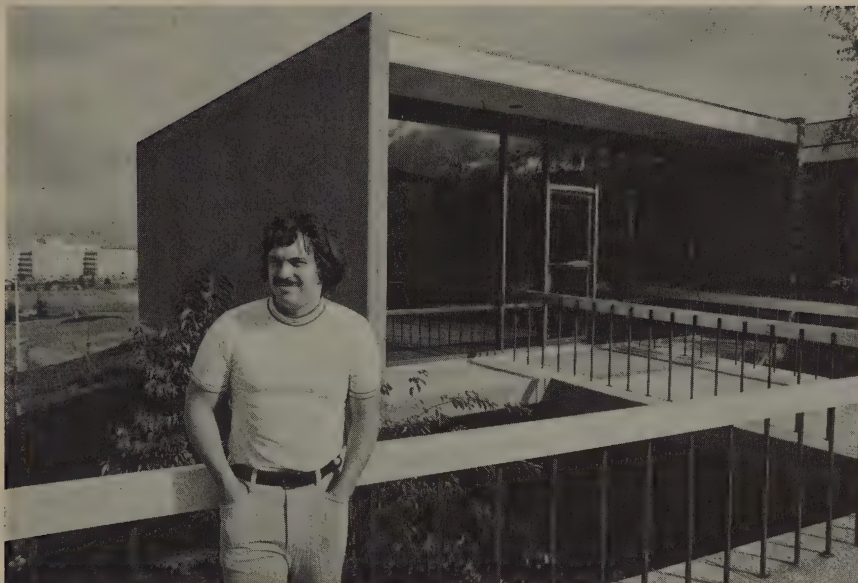
Poor Russia. Do they regret Sputnik and the dialectical forces it unleashed?

The Research Park

THE WESTERN POLE of the U.S. electronics research and manufacturing axis is the San Francisco Peninsula; the eastern end is Boston's Route 128. The tilt of talent is westward.

The Shy Research Center (not their real name) is an idyll, a new building high on a oak-savannahed golden foothill in Stanford's industrial park in Palo Alto, California, a blue-skied shimmery threatless landscape. "Every time I think of that place I start to scratch my balls. It makes me nervous," argues dome and solar designer Steve Baer from dusty Albuquerque, recalling that most of the evil he knows has emitted from similar ivory towers.

Alan Kay, 32, child prodigy (National Quiz Kid at ten), former musician and artist, worked with Ivan Sutherland and Dave Evans at Utah, presently a researcher at Shy. Alan shifts comfortably in his

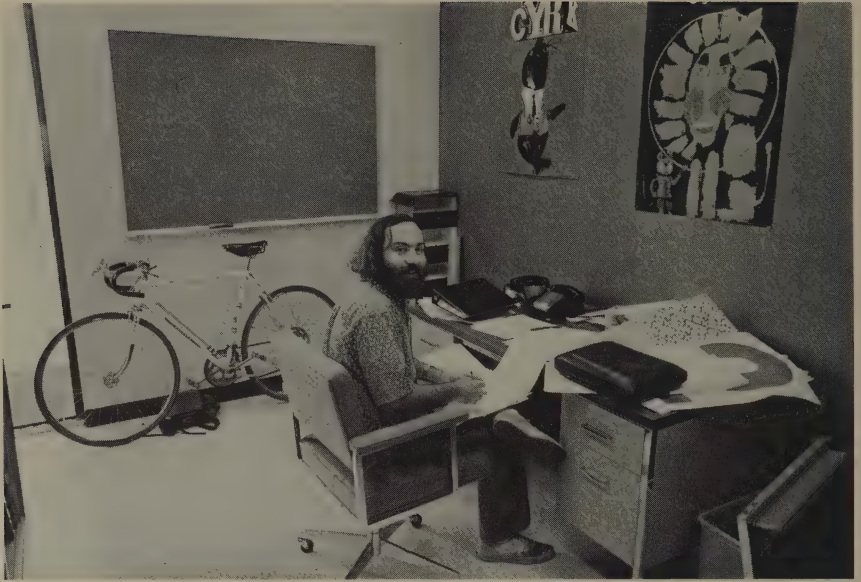


Alan Kay outside the Shy Research Center at Stanford Industrial Park, Palo Alto, California.

office bean bag chair and appraises his colleagues. “This is really a frightening group, by far the best I know of as far as talent and creativity. The people here all have track records and are used to dealing lightning with both hands.”

Peter Deutsch, bearded and intent, 26, veteran of the early days at Project MAC, has served on every major front in computer science, now has a cubicle near Kay’s at Shy Research Center. Alan remarks on his neighbor, “Peter is in my opinion the world’s greatest programmer. He’s much more than a hacker, although he has some of that style. He’s a virtuoso; his programs have very few mistakes. He has probably more written code running than anybody in the ARPA community.”

But Peter doesn’t work for ARPA anymore. One who does, Smokey, at Stanford Research Institute Augmentation Research Center, tells Peter, “You get just a few more agates in that group and you’ll have *all* the marbles.”



Peter Deutsch in his cubicle.

The chief marble collector is—well, well—Bob Taylor. When he left the newly restricted ARPA he spent a year at Utah decompressing from the Pentagon and then went to Shy and there continued his practice of finding and rewarding good men for doing pretty much whatever they considered important work. Freedom to explore in the company of talent is an irresistible lure. In two years Shy had twenty of the best men around working. Toward what? Well, whatever.

I ask Bob Taylor about his position at Shy. “It’s not very sharply defined. You could call me a research planner.” He’s Texas born, trained in experimental psychology, soft-spoken. Where Alan Kay would summarize one of Taylor’s papers with the statement “Economy of scale is one of the biggest frauds ever invented!”, Taylor will respond to a question about the economics of massive operations like huge computer complexes with a long look, a puff of pipe smoke, and a remark that “the benefits are less than claimed.”



Bob Taylor.

And that is the general bent of research at Shy, soft, away from hugeness and centrality, toward the small and the personal, toward putting maximum computer power in the hands of every individual who wants it.

In one direction this means the automated office, replacing paper, desk and phone with an interactive console—affording the possibility of doing the whole of city work in a country cottage. The basic medium here is the text manipulation system developed at Doug Engelbart's Augmentation Research Center, which, as Doug puts it, allows you to "fly" formerly unreachable breadths and depths of your information matrix, of your knowledge. Ask for so-and-so from your file; *blink*, there it is. Make some changes; it's changed. Designate keywords there and there; done. Request a definition of that word; *blink*, presented. Find a quote from a document in a friend's file; *blink, blink*, found. Behind that statement add a substatement giving cross-references and cross-access; provided. Add a diagram and two photos; sized and added. Send the entire document to the attention of these people; sent. Plus one on paper to mail to Washington; *gzzaap*, hard copy, with an addressed envelope.

That's for grownups. Alan Kay is more interested in us kids. He repudiates the manipulative arrogance of "Computer-Aided Instruction" and serves the dictum of Seymour Papert, *Should the computer program the kid or should the kid program the computer?*

Alan is designing a hand-held standalone interactive-graphic computer (about the size, shape and diversity of a **Whole Earth Catalog**, electric), called "Dynabook." It's mostly high-resolution display screen, with a keyboard on the lower third, and various cassette-loading slots, optional hook-up plugs, etc. His colleague Bill English describes the fantasy thus:

"It stores a couple of million words of text and does all the text-handling for you—editing, viewing, scanning, things of that nature. It'll have a graphics capability which'll let you make sketches, make drawings. Alan wants to incorporate music in it so you can use it for composing. It has the Smalltalk language

capability which lets people program their own things very easily. We want to interface them with a tinkertoy kind of thing. And of course it plays Spacewar.”

The drawing capability is a program that Kay designed called “Paintbrush.” Working with a stylus on the display screen, you reach up and select a shape of brush, then move the brush over and pick up a shade of half-tone-screen you like, then paint with it. If you make a mistake, paint it out with “white.” The screen simultaneously displays the image you’re working on and a one-third reduction of it, where the dot pattern becomes a shaded half-tone.

A Dynabook could link up with other Dynabooks, with library facilities, with the telephone, and it could go and hide where a child hides. Alan is determined to keep the cost below \$500 so that school systems could provide Dynabooks free out of their textbook budgets. If Shy Corporation decides to go with the concept, the Dynabooks could be available in two or three years, but that’s up to Product Development, not Alan or the Research Center.



*Kids playing Spacewar
with Dynabook.*

Sketch by Alan Kay.

Peter Deutsch comments: “Processors and memories are getting smaller and cheaper. Five years ago the idea of the Dynabook would have been absolutely ridiculous. Now it merely seems difficult . . . The emergence of computers into society at large has come from a completely different quarter than you’d expect, namely the small calculating machine manufacturers. The current ultimate step in that direction is the Hewlett-Packard Pocket Calculator. They sell for \$400, and they’re essentially a small computer with no program



Alan Kay in bean bag chair.



The Hewlett-Packard Pocket Calculator. As of 1974 it is programmable with magnetic cards.

and very little storage. Wang Laboratories makes calculators which are really computers in all but name—they're programmable; they have lots of storage . . . But still these things only reach thousands of people, not millions. They'll reach millions when computer power becomes like telephone power . . . I think it's important to bring computing to the people."

Counter-computer

HOW MASS USE of computers might go is not even slightly known as yet, except for obvious applications in the schools. One informative place to inquire is among the hackers, particularly at night when they're pursuing their own interests.

One night at a computer center (nameless) I wandered off from the Spacewar game to a clattering print-out machine where a (nameless) young man with a trim beard was scanning columns of entries like, "Pam \$1.59, Bud \$14.75, Annie \$2.66." He was an em-

ployee taking advantage of unbusy after hours time on the computer (computers are never turned off) to run his commune accounts.

“Money seems to be a very sensitive issue,” he explained, “more sensitive than sex, even. People in the house who went on vacation for a week didn’t want to be charged for the food during that time and so forth. It was taking me hours and hours every month to figure out people’s house bills. Now it takes about a half hour a month. Every week I stick up a list on the refrigerator, and anyone who buys food or anything for the house writes it down on the list. I type all that into the computer, along with the mortgage payment and the phone bills and the gas bill. The House Bill Program goes around and divides up the common charges and adds in all the special charges and figures out exactly who owes who how much. Each person at the end of the month gets a bill plus a complete breakdown of what their money goes to.”

What else goes on around here in moonlight mode?

“A friend of mine has his recording tape library index on the computer. Everyone does their term papers and their theses on it. It’ll justify margins, incorporate corrections, handle illustrations, paging, footnotes, headings, indexing. . . . Two years ago when we had the great faculty strike against the War, we rigged up a program that would type out a form letter to all your congressmen and type in your name and address.

“Bruce is working on an astrology program. You put in your birthplace and date, down to the minute, and it gives you all your aspects, your chart. You can get your progress chart too . . . One of the hackers is building a computer at home out of Army surplus parts, and he’s using the facilities here to help his design, because we have this huge battery of computer design programs.”

Indeed. Far beyond borrowing someone else’s computer is having your *own* computer. Hear now the saga of Pam Hart and Resource One. In 1969 Pam was a computer programmer at Berkeley who found the work “just too disillusioning. Then during the Cambodia Invasion demonstrations in Berkeley a group of us got together and designed a retrieval program for coordinating all of the actions on

campus. It was a fairly dead system, but what it did was it brought together people who had never worked together before and started them talking and thinking about how it was actually possible to do something positive with technology, when *you* define the goals.”

Computing power to the people. So began one of the great hustles of modern times. Peter Deutsch is still awed: “Pam could hustle blood from a turnip.” She speaks quietly in a hasty, gentle, self-effacing murmur. You have to lean close to hear the lady helping you help her to plant dynamite in the very heart of the Combine.

“Four of us came from Berkeley to Project One and set up in a little office on the second floor. [Project One is a five-story warehouse in the south-of-market area of San Francisco. It started in 1970 with a radio announcement, “If you’re interested in building a community and cheap space and sharing resources, come to Project One.” Within two weeks the building was filled with 200 artists, craftsmen, technicians and ex-professionals, and their families.] We worked on designing a retrieval system so all the switchboards in the City could interact, using a common data base, with all the care taken for privacy and knowing who put stuff in so you could refer back. Hopefully you could generate lists that were updated and be as on-line as possible.

“We found that it just did not work using borrowed time, stolen time, bought time—we couldn’t afford it. So about a year later we set about getting surplus. After a couple of months of calling everybody in San Francisco that was related to computers, Transamerica said that they had three XDS 940s in a warehouse [each costing \$800,000 new].

“We negotiated the contract, got a 940 [free], which we refurbished. It arrived last April; we installed it in June. It was probably the fastest machine installation ever: We had it up in three days. We were really fortunate the whole time. We had a lot of people from Shy, a lot of the old people from Berkeley Computer Corporation, that have assisted us in areas where we weren’t totally sure of the appropriate thing to do ourselves. Peter Deutsch brought up the operating system.



Pam Hart and XDS-940 guts.

“Now we’re a little more stable economically. We got a foundation grant of \$10,000 last November from Stern. Then we borrowed \$8000 from the **Whole Earth Catalog**, of which we paid back six. [News to me. This was part of the \$20,000 I had turned over to the mob at the Catalog Demise Party. One Fred Moore

finally signed for \$15,000 of it and ran a series of subsequent consensus money decidings, which evidently were susceptible to Pam's soft voice and clear head.] After two years we're right there at the beginning point of actually being able to do the things that we said we wanted to do.

"One of the first things we have to do is have a retrieval system that's general enough that it can handle things like The Switchboard referral information, also people who are doing investigative work on corporations, people doing research on foundations, a whole lot of different groups either willing or not willing to share data bases. There's a man on the East Coast who's designed a very good retrieval system that's working on a PDP-10, and we'll try to put that on our system. He's spent seven years working that all out, he's of the same politics, and his whole orientation is using technology so that the user can *use* it.

"We're interested in some health care statistical systems. There are a lot of Free Clinics in the City, and they have to do all of their work by hand. There are also a lot of Health Centers in the City, and they have government money that's earmarked for data processing. They pay very large quantities of money for that, and also their turnaround time is about a month [takes that long to get processed data back]. We want to incorporate a system doing statistical work for the clinics, charging the Health Centers that have money and not charging the Free Clinics that don't have money.

"A third area is using government-generated tapes like assessor's tapes and census tapes, and start trying to do some analysis of the city. Like: one of the things we found out doing research in the Mission is that a lot more money is put into the Mission banks by people who live there than is given out in loans.

"And the education program. The ideas include what People's Computer Company is doing—set up a little recreation center where people could come and play games, and hopefully some of them would be learning games. And then I'm interested in doing community education with video tape. People want to know about computers, not how to use them, necessarily, but how they're used against them."



Resource One crew at Project One.

Counter-computer. At present there are ten people in the core group at Resource One ranging in age from 19 to 30 (Pam is 25), with decisions made by consensus.

Another scheme in the works involves the people around Steve Beck at the National Center for Experiments in Television a few blocks away. Steve has built the world's first real-time video synthesizer—the video equivalent of the Moogs, Buchlas, and Arps of music synthesis. It's a natural to link up with a computer. The current plan is for Steve and his equipment to move into the basement below Resource One, which should liven up the scene—Pam's gang is short on true hacker time-wasting frivolity; they're warm, but rather stodgier than some of the Government-funded folks. Maybe the video link-up will give us some higher levels of Spacewar on the way to exploring new territory entirely. If I were a computer manufacturer I'd pay the closest attention and maybe donate some goodies.

Control and Spontaneity

I'M NO MANUFACTURER, but I'm a hungry enough potential user to pretend briefly that I know what I'm talking about and run a trial polemic . . .

Until computers come to the people we will have no real idea of their most natural functions. Up to the present their cost and size has kept them in the province of rich and powerful institutions, who, understandably, have developed them primarily as bookkeeping, sorting and control devices. The computers have been a priceless aid in keeping the lid on top-down organization. They are splendidly impressive as oracles of (programmable) Truth, the lofty voice of unchallengeable authority.

In fact, computers don't know shit. Their especial talent in the direction of intelligence is the ability to make elaborate models and fiddle with them, to answer in detail questions that begin "What if . . . ?" In this they parallel (and can help) the acquiring of intelligence by children. But the basic fact of computer use is "Garbage In, Garbage Out"—if you feed the computer nonsense, it will dutifully convert your mistake into insanity-cubed and feed it back to you. Children are different—"Garbage In, Food Out" is common with them. Again, the benefits of variant parallel systems. Computer function is mostly one-track-mind, in which inconsistency is intolerable. The human mind functions on multiple tracks (not all of them accessible); it can tolerate and even thrive on inconsistency.

I suggest that the parallel holds for the overall picture of computer use. Where a few brilliantly stupid computers can wreak havoc, a host of modest computers (and some brilliant ones) serving innumerable individual purposes can be healthful, can repair havoc, feed life. (Likewise, twenty crummy speakers at once will give better sound fidelity than one excellent speaker—try it.)

Spacewar serves Earthpeace. So does any funky playing with computers, any computer-pursuit of your own peculiar goals, and especially any use of computers to offset other computers. It won't

be so hard. The price of hardware is coming down fast, and with the new CMOS chips (Complementary Metal Oxide Semiconductor integrated circuits) the energy-drain of major computing drops to flashlight-battery level.

Part of the grotesqueness of American life in these latter days is a subservience to Plan that amounts to panic. What we don't intend *shouldn't happen*. What happens anyway is either blamed on our enemies or baldly ignored. In our arrogance we close our ears to voices not our rational own, we routinely reject the princely gifts of spontaneous generation.

Spacewar as a parable is almost too pat. It was the illegitimate child of the mating of computers and graphic displays. It was part of no one's grand scheme. It served no grand theory. It was the enthusiasm of irresponsible youngsters. It was disreputably competitive ("You killed me, Tovar!"). It was an administrative headache. It was merely delightful.

Yet Spacewar, if anyone cared to notice, was a flawless crystal ball of things to come in computer science and computer use:

- 1) It was intensely interactive in real time with the computer.
- 2) It encouraged new programming by the user.
- 3) It bonded human and machine through a responsive broadband interface of live graphics display.
- 4) It served primarily as a communication device between humans.
- 5) It was a game.
- 6) It functioned best on standalone equipment (and disrupted multiple-user equipment).
- 7) It served human interest, not machine. (Spaceware is trivial to a computer.)
- 8) It *was* delightful.

In those days of batch processing and passive consumerism (data was something you sent to the manufacturer, like color film), Spacewar was heresy, uninvited and unwelcome.

The hackers made Spacewar, not the planners.

When computers become available to everybody, the hackers take over: We are all Computer Bums, all more empowered as individuals and as cooperators. That might enhance things . . . like the richness and rigor of spontaneous creation and of human interaction . . . of sentient interaction.



Appendix One: *Access to Computers*

AS ANDY MOORER puts it, “Basically all you have to do is read a book on computer programming, and you’re an instant computer scientist.” Alan Kay insists that most of computer science can be mastered in one year of close attention. That’s how young a science it is.

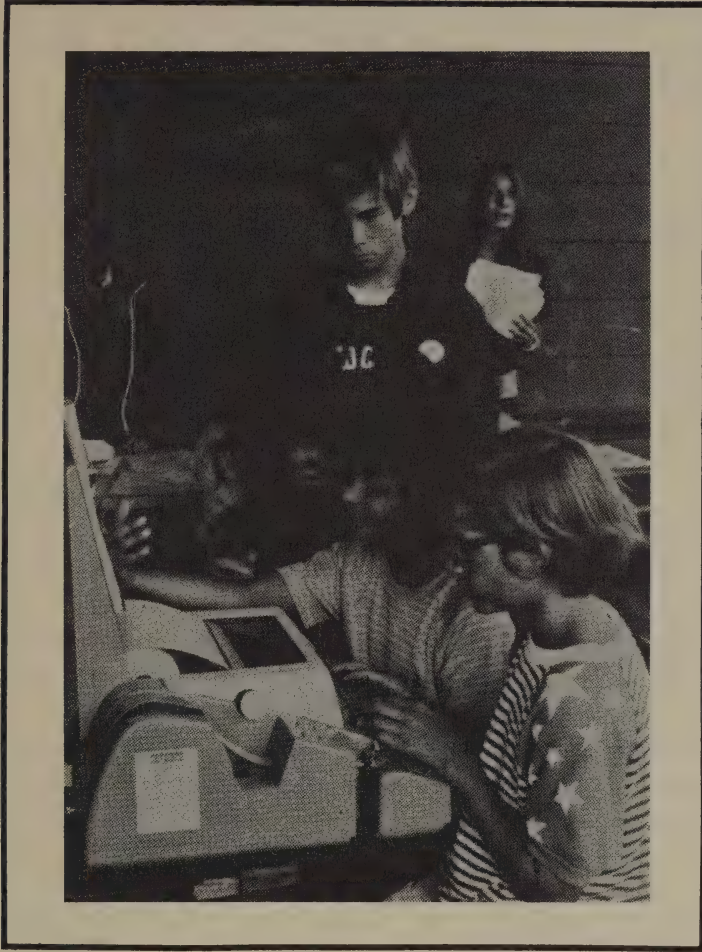
The main thing is getting with computers. If you live near a university or have family in a business that uses computers, you may be able to wangle moonlight time and informal instruction.

If you’re in school (college, high school, grade or Free) it shouldn’t be too hard to con them into buying some decent equipment—tell them they can use it for school accounts at night. According to Bob Albrecht of People’s Computer Company, the best school computers are from DEC and H-P: “Both of these companies have made a real commitment. They have qualified educational staffs, they’re developing new stuff, they’ve got credibility.”

Write to:

- David Ahl, Digital Equipment Corporation, 146 Main Street, Maynard, Massachusetts 01754. (Ahl has authored an excellent book, **101 Basic Computer Games**, \$5 from DEC.)
- Ed McCracken, Hewlett-Packard, 11000 Wolf Road, Cupertino, California 95014.

DEC has what they call Edu Systems, three families of computers ranging from a single-terminal PDP-8 (\$7K [\$7,000]; can handle up to 16 terminals) to the big PDP-10 (\$500K). And H-P has their 2000-series, ranging from the 2000E (\$40K) to the 2000C (\$300K).



*Glyph on page 79 and above photo
from **People's Computer Company.***

Some school systems are starting miniature ARPA Nets. Bob Albrecht reports, "Minnesota may become the first state to have a statewide network where every kid will have access to a computer. There are more than 200 schools and 30,000 kids already tied into the network. And Long Island has a consortium with 40 schools on a PDP-10."

Finally, there are starting to be places where one can step in off the street and compute, and some of these have newsletters, games, etc., that they can send you. Write to:

- Bob Albrecht, People's Computer Company, Box 310, Menlo Park, California 94025. (Publishes an outstanding newsletter on recreational and educational uses of computers. \$4 for 5 issues/year.)
- Bob Kahn, Lawrence Hall of Science, University of California, Berkeley, California 94720. (16 terminals available at 50 cents/hour. Publishes a newsletter, **Kaleidoscope**; has some interesting games.)
- Rusty Whitney, Oregon Museum of Science and Industry, 4015 SW Canyon Road, Portland, Oregon 97221. (Public access computers. Has better software for the PDP-8 than DEC has. And has new PDP-11.)
- Bill Mayhew, The Children's Museum, Jamaica Way, Boston, Massachusetts 02130. (Public access computer games.)

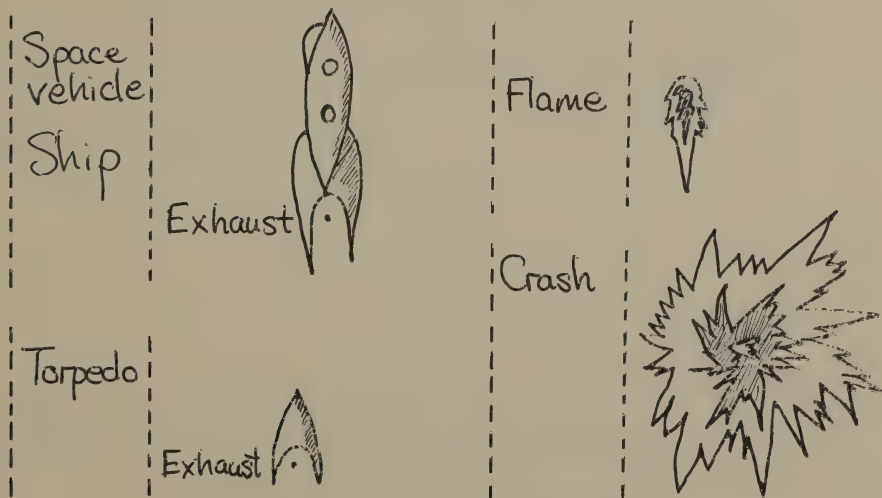
If you're looking for good computer science in a college, the best is Carnegie-Mellon at Pittsburg, then Stanford and MIT, with Utah, Cal Tech, and Illinois following. The college that exposes more of its students to computer use than anyone is Dartmouth.

Appendix Two: Your Own Spacewar

THOUGH NO ONE has done it yet, Alan Kay is convinced a modest Spacewar could be built cheap: "You can do motion with a couple of integrators. Heathkit has this 16-integrator analogue computer you can build as a kit for 700 bucks or something like that. You have to have two layers of integrators to get an inverse-square law, so you should be able to get gravity and orbits with that one. To make spaceship outlines and explosion patterns you need a few bits of digital memory. Two chips worth of register file should do it. I think electronics stores may carry the chips.

"The controls for Spacewar are trivial. The simplest way is to go to a radio control store—like for model airplanes—and get the front end of the radio controller, which has two sets of joysticks and the pots and everything else. You can use those as the inputs to the analogue computer. They only cost something like thirty bucks."

Once you have the computer, your own or someone else's, you can write your own Spacewar program or start with this one of Kay's:



Do firsttime : shape □ at : position : direction
□ state : speed : roll : no. of torps
□ controls : thrust : point : trigger

Left roll \leftarrow roll + point

Forward speed \leftarrow speed + thrust

If thrust $>$ ϕ

then Show shape contrast \equiv flame

else Show shape

If trigger on and number of torps $>$ ϕ

then Spacevehicle torp at position direction.
state speed +10 roll ϕ
controls 5 ϕ "off"

If touch

then Quit touch. Show Crash. Quit self.

A year passes.

Epilog II

Primordial Fuzz

(December, 1973)

MY CLAIM THAT COMPUTER SCIENCE is moving fast comes now to the test (the spot quiz anyway). What's new a year later?

Spacewar is as popular as ever but unchanged. The design of the game appears to have plateaued. Meanwhile, a commercial two-person computer game called 'Pong' has swept the airports and bars of America, encouraging the manufacturer (Atari, 14600 Winchester Boulevard, Los Gatos, California) to develop 'Pong Doubles', 'Space Race', and a particularly ingenious game called 'Gotcha' which involves a chase through a labyrinth which is continually changing on the display screen.

(Readers may be wondering what is my obsession with all these games and their details. All I can articulate is that I'm following a hunch which relates somehow to Gregory's notion of evolving ideas. A game is an idea with its own life, growth, reproductive cycle, and adaptive response to other life. The same can be said of a good story. But what makes a game "good" or a story "good"? The question is cybernetic.)

A year later Les Earnest at the Stanford Artificial Intelligence Lab reports they're working on a project "where you could design

something on the screen and then have the computer directly control a milling machine to make it. So, from design to finished object would be minutes.”

Ralph Gorin, I gathered, is busy on a new time-sharing system. Bruce Baumgart, the Spacewar free-for-all winner, is trying to finish his Ph.D. thesis on computer vision. Tovar is still around “sporadically”, though unpaid. Rem was encouraged to move on and got a job elsewhere.

The ARPA Network is getting more use. People are leaving messages and conversing directly—keyboard to keyboard—over it. They’re even mingling programs to work simultaneously on a problem. AI’s providing access to Associated Press wire service for the Net has been enormously popular. Les: “Whenever there’s a big news story people come crashing in on our system from all over and just saturate us. We’ve had to pull the plug on them a couple of times so we could get some work done.”

Larry Roberts has left ARPA-IPT and been replaced by the founder, J.C.R. Licklider—“a real statesman,” notes Bob Taylor.

Publication of the “Computer Bums” article in **Rolling Stone** provoked several letters-to-the-editor remarking that ARPA is not all *that* innocent and benign. Robert Seidman in Syracuse, New York, wrote, “Much of the artificial intelligence research sponsored by ARPA will be or already has been applied to the Pentagon’s Electronic Battlefield. The Electronic Battlefield makes ‘smart’ laser-directed bombs seem like kid’s stuff. Visual and acoustic sensors transmit information to a computer which with the aid of artificially intelligent pattern recognition programs miraculously differentiates between a water buffalo, peasant child and Viet Cong and calls in air strikes. And just wait ’til they bring the Battlefield home to the States.”

Bob Taylor, still at the Shy Research Center, has become a collector of computer games. He started his collection through the ARPA Net’s Games Directory: “You type a command that then ships the bits from their computer to your computer and sticks it in a file. Then you can work on them selectively.”

I asked Bob what was new in computer science in terms of ideas. "The challenges are clearly in the programming world. With small microprogrammable machines there's a set of experiments that we can do with regard to reconfiguring through their microprogrammability their basic instruction set to make it execute some higher level languages directly. You could build really cheap special purpose processors for special purpose jobs that will allow people who don't have to be computerists to execute those jobs."

There's an irony I should report in the aftermath to the Stone article. Humorless ARPA had been treated very gingerly lest it crack down on funding for local projects. The cheerful "Shy" Company was reported on—praised—blithely, real name and all. ARPA never made a peep about the article, but Shy's east coast headquarters embarked on a major flap about unauthorized information, photos, four-letter words, and the scurrilous **Rolling Stone**. A year later I was asked would I please not reprint the article (no), or at least take out the embarrassing parts (bad language, compliments among colleagues, and optimism about projects; no), or how about just leave out the company's name? (OK. That's equivalent to how I treated the ARPA material.) Image control.

Meanwhile the research center is nifty as ever. Virtuoso Peter Deutsch is working on interactive systems for secretaries. They're part way along on the Dynabook fantasy with a working personal computer the size of a breadbox. Alan Kay: "We can do real time animation of sketches like the Saturday morning cartoons on TV. We can do a simulation of very high quality musical instruments such as a baroque pipe organ. We're putting a whole bunch of these in a building in town as a resource center for kids."

I asked Alan how energy shortages will affect computer use. "The Dynabook will run on about 50 watts. You know, a person's head only uses 25 watts. That's basically sugar—glycogens. Control is all on the molecular level. You can go to the stars in your head. . . . Twenty years from now a person with two square yards of present-day solar batteries could easily refresh all the electronic devices he's likely to use."

Resource One is still functioning at 1380 Howard Street in San Francisco, with ten people working on surveys for Aid For The Aged and the Neighborhood Legal Assistance Foundation, and handling mailing lists for the National Lawyers Guild, Bach Mai Hospital Fund, Institute for the Study of Nonviolence, and Center for Rural Studies. Their most interesting project was a “community memory” teletype computer terminal at Leopold’s Records in Berkeley. People put in notices, comments, poems, etc. for public use. The video-synthesizer guy never moved into the basement. Financially Resource One is on the verge of self-sufficiency.

Pam Hart left them last June (“It was time”), travelled in Europe a while, and now is occupying an interim period with night school in electronics and a job with Resource Exchange, which distributes donated equipment to San Francisco community groups. She’s not particularly happy with me or my enthusiasms. As for Gregory Bateson, “A friend of ours came over and said, ‘This guy is fantastic, he’s wonderful, he’s got the truth.’ I said, ‘Tell me what it is.’ And he read to me this section about men and women—how women nurture and men squander. And then there’s an actual analogy drawn from that garbage information. It’s off the wall. I’m not naturally monogamous. I doubt that you’re naturally polygamous. I object to drawing sexual assumptions about men and women from the way a child is born, when a lot of those things are cultural and have to do with—especially with—economics.”

What *are* these Epilogs?

I guess they serve somewhat as antidotes to the artificially concentrated focus of the articles. In *time* people and concerns disperse, ideas interweave, fade, and become unrecognizable. Reports such as this book alter what they report and hasten their own obsolescence. Events prove much less clear and much more full of their own perverse life than tidy articles can indicate.

The primordial fuzz, a friend called it. “Yep, it’s all connected and unknowable.”

That’s a dumb way to end.

I’m adding something else here, the most artificially isolated form of discourse there is, a proposal. It’s part of a position paper I wrote for POINT (the foundation which dispenses funds from the **Whole Earth Catalog**) back at the time of POINT’s founding in the Fall of 1971.

Take the notions of game, story, cybernetic design, and cultural/economic/ecological coevolution, freeze-dry, dissolve in lysergic acid, and serve: Softwar.

Softwar

MANKIND MUST LOVE WAR, it makes so much of it.

That understanding precedes any hope of solving our current war problems, which are twofold.

For one thing our sanctimonious denial of affection for conflict obliges us to proceed hypocritically and self-blinded into the very cauldron. We're like Victorians were about sex, which led—and leads—straight to the whip.

For the second thing, our battles have famously outgrown our battlefield. The world's too fragile for another World War with current weapons and rules. Boom doom.

I would propose to lighten the situation with no more than what children spontaneously do with their energy: play rough, but only so rough. Children have a ferocious sense of fairness to match the often ferocious games they play, which involve deliberate risks, hurts, frights, fights, strategies, victories, defeats, and absolutely arcane ritual. And then they go home to supper.

One may protest that kids games don't have issues like wars do. I suggest that war's pompous issues mostly boil down to territory and rank, which also gets settled in child's play.

Worth noting is the adult contribution to the games: "Play outside!" It's no trivial addition, for it insures that there will be a kitchen left to make the supper to go home to.

I suggest that it's time to turn the fortress inside out, send the conflict inside.

We should indeed offer people an arena, a place where there is excitement, danger, rewards, lessons, conflict, strangers, adventure. Robert Ardrey reminds us that Calhoun's famous overcrowded rats *sought out* the 'behavioral sink' in the middle pens where cannibalism, perversion, gang war, insanity reigned. Wife Lois comments: "They went slumming."

What if social stability is impossible without ample occasion for every one of our postal employees to rape or be raped? All I would require is that involvement in the arena be voluntary, and so distinct from our present ghetto system. We shall have arenas anyway, always-have-always-will, and for good reasons. Designing them only gives us a chance to contain them, reduce permanent injury, be sure that the shout of "Unfair!" can be heard.

If arena-activity permeates the streets and countryside, then security may be found only in fortresses, islanded in a sea of fighting. If, however, arena activity is regionalized, then there would be islands of fighting in a sea of security. The safe portion of living could wander in a kind of park, with warfare contained *behind* fortress walls.

(Of course there will always be a certain amount of healthy scorn for conventional arenas, and the scorers will properly find their own spontaneous, deadly, original arenas, which may in turn instruct or replace the conventional.)

What I'm predicting, or promoting, is re-design of current war forms. Cold war showed us some advantages over hot war, and some disadvantages (such as boredom, frustration, routine cheating, and a kind of paralysis). I'd prefer the hard-soft continuum for terminology and suggest that we work on *softwar*.

For starters, let *softwar* mean conflict which is *regionalized* (to prevent injury to the uninterested), *refereed* (to permit fairness and the certainty of a win-lose outcome), and *cushioned* (weaponry regulated for maximum contact and minimum permanent disability). If you don't see much difference between *softwar* and sports you're getting the point.

Softwar, thus, is a formal arena, which offers the possibility of settling formal group differences. Economics, political, social stakes may be set and won. I suppose it's a form of the old fantasy of sending the warring national leaders up the mountain to fight it out alone, only with softwar a few more people get in on the fun.

In T. H. White's version, King Arthur got the armored rich people ("knights") to stop clobbering the unarmored poor people by luring all the armored people together into a high tone clobbering club, with chivalry, girls, and pennants.

Let Audie Murphy, Henry Kissinger, and Howard Cosell work the same playing fields. Let Martin Buber and Pope John train the referees.

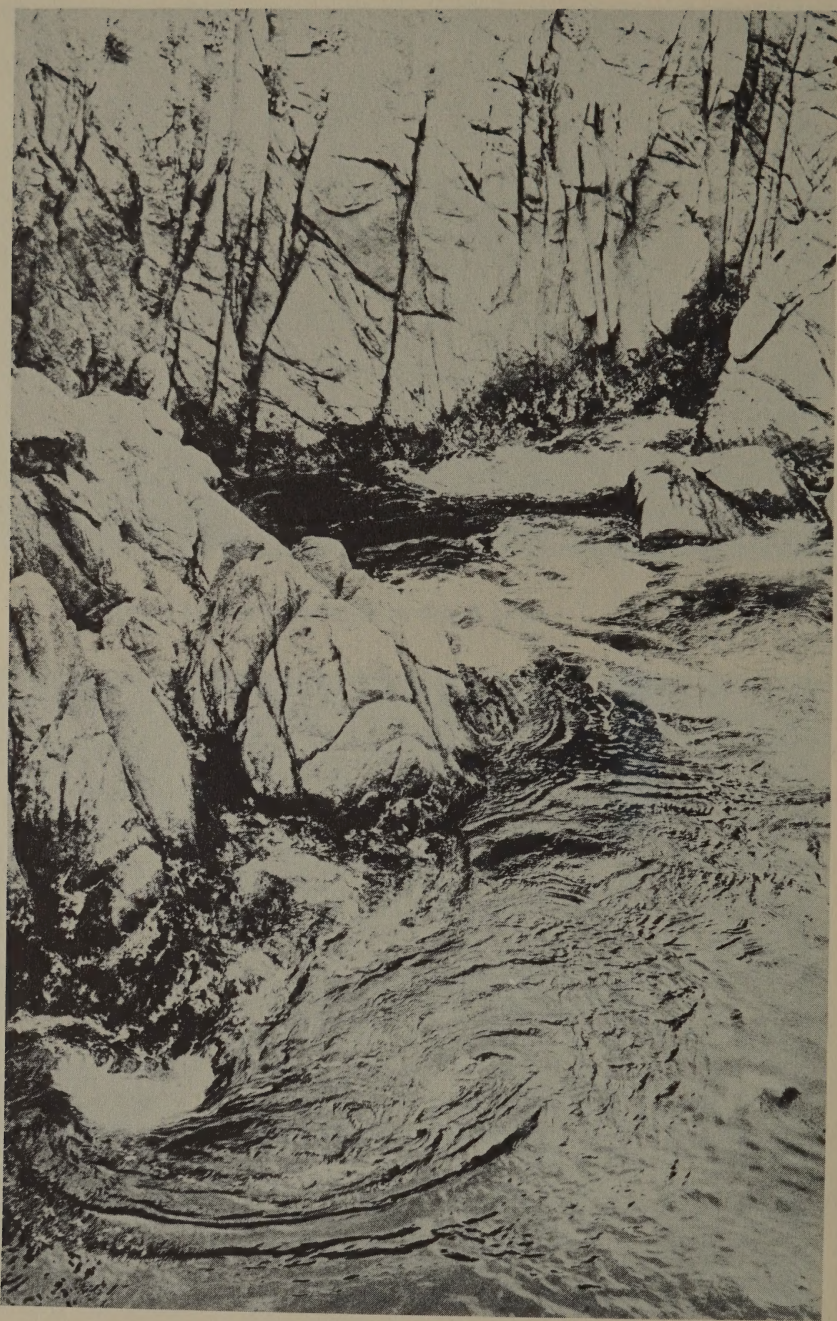


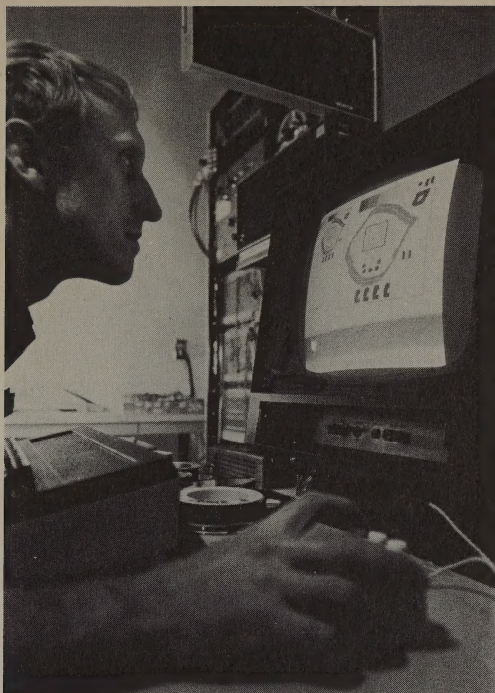
Computer Spacewar

This book is dedicated to the bond

Galaxy Cluster

because the difference is the bond.

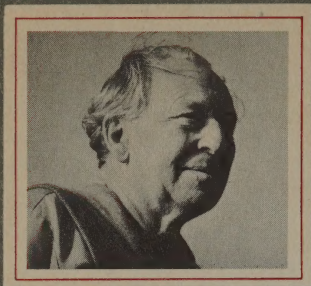




Author Brand doodling with Alan Kay's computer paintbrush program.

STEWART BRAND. Born December 14, 1938, Rockford, Illinois. Phillips Exeter Academy, 1956. Stanford University BA (Biology), 1960. U.S. Infantry Lieutenant, 1960-1962. Exhibits: with Gordon Ashby, "Astronomia" (1964); with USCO, "We Are All 1" (1966). Designed and performed shows: "America Needs Indians" (1963-1965); "Why Haven't We Seen a Photograph of the Whole Earth Yet?" (1966); "WAR:GOD" (1967-?). Designed public events: "Trips Festival" (1966); "Whatever It Is" (1966); "World War IV" (1967); "Liferaft Earth" (1969); "Demise Party" (1971); "Life Forum" (1972); "New Games Tournament" (1973). Received Acid Test diploma, 1966. Edited and published **Whole Earth Catalog** (1968-1971). Received National Book Award for Contemporary Affairs, 1972. Married to Lois Jennings (1966-1973). Director of POINT Foundation (1971-1974).

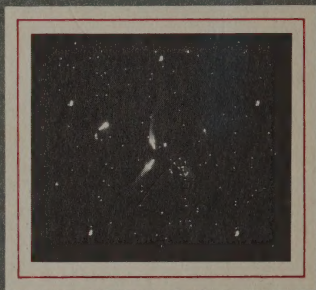
Presently lives in San Francisco, speaks occasionally (via Harry Walker, Inc., 21555 Duncan Road, Monte Rio, California 95462), and edits **Whole Earth Epilog** and its Supplement **The COEVOLUTION Quarterly** (Box 428, Sausalito, California 94965).



GREGORY BATESON

- *To want control is the pathology, not that the person gets control, because of course you never do.*
- *You cannot induce a Pavlovian nervous breakdown in an animal out in the field.*
- *Job's sin is that he's pious. . . . The correction for piety is natural history.*
- *All differences are things of the mind.*

COMPUTER SPACEWAR



HOW MANY SPACE MINES DO YOU WANT?

- *One of the hackers wrote a program called "The Unknown Glitch", which at random intervals would wake up, print out I AM THE UNKNOWN GLITCH. CATCH ME IF YOU CAN, and then it would relocate itself somewhere else in core memory, set a clock interrupt, and go back to sleep. There was no way to find it.*
- *Computer function is mostly one-track-mind, in which inconsistency is intolerable. The human mind functions on multiple tracks (not all of them accessible); it can tolerate and even thrive on inconsistency.*
- *Ready or not, computers are coming to the people.*